THE IMPACT OF MERGER ON THE FIRM'S EQUITY RISK: EX-ANTE VERSUS EX-POST ANALYSES

By

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The objectives of this study are (1) to examine the impact of merger on the firm's equity risk, (2) to test the consistency and substitutability of ex-ante and ex-post risk measures and their effects due to merger, and (3) to evaluate the extent to which accounting information can be used to assess changes in equity risk after merger. Three types of evidence were investigated to attain these objectives. First, the behavior of implied standard deviation derived from the option pricing model served as the ex-ante measure of stock volatility before and after merger. Second, the historical time-series standard deviation of daily returns was employed as an ex-post risk measure. Finally, accounting-based variables were evaluated in terms of their ability to explain and predict risk changes due to merger.

The evidence of this study demonstrates a reduction of market-based risk measures in both merger and control firms. No distinction, however, can be made for changes in equity risk between both groups.

The observed risk changes can be attributed, not to merger, but to the instability of risk variables over time. Both ex-ante and ex-post measures of risk changes were consistent in all cases. The historical time-series standard deviation of returns was a viable alternative in approximating the future stock volatility of merger firms before merger. After merger, however, the ex-ante risk measure might be a better proxy for the future equity risk, due to an inferior predictive ability of the historical time-series standard deviation. One accounting risk measure that was significantly different between merger and control samples was debt-equity ratio. The decline in equity risk due to an increase in firm size after merger was partially offset by an increase in financial leverage, which was attributed to a coinsurance impact and shareholders' protective actions. The findings do not support the contention that merger firms experience larger risk changes than similar nonmerger firms. Thus, results are consistent with prior studies that use systematic risk measures.

CHAPTER I
INTRODUCTION

A merger is an investment decision aimed at increasing the firm's market value, reducing the risk of the firm, or controlling markets. Mergers may occur when two firms agree to combine under legal processes or when an acquiring firm first offers to purchase a proportion of the shares of the target firm (a tender offer) and buy the rest of the shares at a later time. The question of what constitutes a good merger is yet to be resolved. Theoretically, the benefits for horizontal mergers and vertical mergers accrue from positive economic synergistic effects; i.e.,real gains from favorable integration of production, sales, distributions, etc. Other benefits include tax loss carry forwards and better access to external capital markets for larger firms. Conglomerate mergers, though not known to have conclusive evidences of real synergies, are also considered beneficial due to their diversification effects. One question raised in this study is the extent to which the merger of two firms with unrelated earnings streams reduces risk as measured by the variability of returns over time. Previous studies show that risk can be reduced through the diversification effect of merger (Levy and Sarnat [1970], Lewellen [1971], Higgins and Schall [1975], Kim and McConnell [1977], for example). Equity risk is important in investment decisions. In a mean-variance context, investors generally demand higher returns for higher risk firms. Even though a high price is paid for acquiring new firms,

evidence has shown that the new firms do not gain abnormal profits (e.g., Asquith [1983], Eckbo [1983], Dennis and McConnell [1986], and Amihud, Dodd, and Weinstein [1986]). With no significant increase in returns, it can be argued that the evidence on risk may also provide inconclusive results.

Another question concerned in this study is which alternative measures should be a good approximation of equity risk that is being changed as a result of merger. Three approaches in measuring the equity risk have been suggested: (1) the implied standard deviation imputed from option prices (Latane and Rendleman [1976] and Patell and Wolfson [1979,1981]); (2) the historical time series standard deviation of equity returns (Markowitz [1952,1959] and Black and Scholes [1973]); and (3) accounting risk measures (Beaver, Kettler, and Scholes [1970]). The evidence has shown that the implied standard deviation is a better approximation of future equity risk than a historical standard deviation of returns (e.g., Latane and Rendleman [1976] and Chiras and Manaster [1978]). Consequently, given the implied standard deviation is used as a benchmark for the ex-ante risk measure, this study attempts to examine the extent to which ex-post risk measures, i.e., a historical standard deviation of equity returns and accounting risk measures, can be used as viable alternatives of an ex-ante risk measure.

In summary, given the growing importance of mergers nowadays, this study aims at examining the following issues:

1. Whether merger has any impact on the equity risk of the firm.

2. The substitutability of alternative ways for determining the change in risk due to merger.

3. The extent to which accounting numbers can be used to evaluate risk changes due to merger.

The remaining sections of this chapter disscuss the research problem, an overview of investment risk, and the organization of the study.

Research Problem

Equity risk as measured by the variance or standard deviation of returns has several important roles in finance and accounting research. A component of risk called systematic risk is central to capital asset pricing and portfolio theories (Sharpe [1963, 1964] and Lintner [1965]). Total risk measured as return variance also plays a significant role in the pricing of contingent claims (Black and Scholes [1973]). Finally, the return variance also has an important role in information content hypothesis testing (Beaver [1968], Patell and Wolfson [1979, 1981]). The knowledge of the risk generating process in a model of investor expectations is essential in decision making regarding portfolio selection strategies, leading to an efficient allocation of resources. The capital asset pricing model (CAPM) and the option pricing model (OPM) are examples of investor expectations model that specify the risk measures in terms of market determined variables. The accounting system has a role in providing information to facilitate decision making. The relationship between the accounting-determined and market-determined measures of risk can assist in classifying the riskiness of firms. An example is the use of financial ratios as measures of default risk in credit and investment decisions (e.g., Beaver [1966], Altman [1968], and

Ohlson [1980]). Therefore, research on accounting risk measures is a worthwhile endeavor.

One event that can significantly change investor expectations regarding the riskiness of a firm is merger. The behavior of price changes during and after merger can reflect the realization of the firm's real riskiness that is more or less than its expectation. Thus far, the empirical evidence reporting on the effects of merger on equity risk is based on using historical data to examine return volatility before and after merger (for example, Weston and Mansinghka [1971]; Melicher and Rush [1973]; Haugen and Langetieg [1975]; Gahlon and Stover [1979]; and Langetieg, Haugen, and Wichern [1980]). However, this evidence has been inconclusive. The mixed results are obtained for several reasons, some of which are the following:

1. Estimating historical volatility of returns typically requires a larger number of observations. Since the choice of the estimation period is arbitrary, it may cover periods with differing volatility.

2. Using lengthy time periods to estimate risk increases the possibility of including confounding events.

3. Information about investors' expectations are not utilized.

These same problems have occured in other information content studies. As a partial remedy, Patell and Wolfson [1979,1981] suggested the use of implied standard deviation generated from option pricing models to measure the ex-ante information content of earnings announcements. The call options are appealing since they provide a particular instrument for information content testing. The call price basically captures the relationship between its value as a contingent

claim and investor beliefs about the future stock volatility over the remaining life of the option. Changes in the variances of common stock returns due to an anticipation and a realization of new information can then be detected from changes in call prices.

Since the implied standard deviation is an estimate of the market risk of stock at the time of measurement, it suffers less from the problems cited above. The research question of the effect of merger on equity risk can then be examined by evaluating the ex-ante stock volatility estimated by implied standard deviations (ISD). In addition, the consistency of the ex-post and ex-ante measures of risk can be examined.

Accounting data provide exogenous measures of risk different from market-based data (see Beaver, Kettler, and Scholes [1970]; and Bowman [1979]). Therefore, the extent to which accounting variables are impounded in the market-based measures of risk is also investigated. The historical standard deviation of stock returns and accounting proxies for financial risk and operating risk in addition to market risk are used as ex-post risk measures. By evaluating the predictive ability of accounting-based risk indicators, some guidance can be provided as to the extent to which accounting proxies are useful indicators of equity risk in cases where ex-ante risk estimates cannot be directly evaluated (e.g., when firms do not have options traded).

An Overview of Investment Risk

Risk is defined as a chance of injury, damage, or loss. An act of risk taking, consequently, involves a possibility of both favorable and

unfavorable outcomes. Higher risk makes the loss more likely, and the lower risk makes it less likely. Rothschild and Stiglitz [1970] define increasing risk value as involving more noise, more chances of loss, higher variance, and less preferability to every risk averter. In an investment decision, the risk an investor bears is the risk of loss in portfolio returns.

One common measure of investment risk is the variability of returns. Within the CAPM context (Sharpe [1964], Lintner [1965], and Mossin [1966]), a stock's variability can be decomposed into two components: (1) the systematic (nondiversifiable) risk, resulting from covariation of an individual security return with the market return; and (2) the nonsystematic (diversifiable) risk, attributable to the specific risk characteristics of the individual firm. While risk decomposition can be based on either variance or standard deviation, Ben-Horim and Levy [1980] argue that the risk decomposition should be based on standard deviation rather than on variance. The reason is that variance decomposition will not distinguish the stock with negative beta from that with positive beta since they will yield the same proportion of nonsystematic risk. The use of standard deviation is consistent with the CAPM formulation and takes the sign of beta into account. This position is confirmed by van Zijl [1987] who examines the risk decomposition based on standard deviation with the extended CAPM.

As long as nonsystematic risk is positive, adding a stock into a portfolio will lend stability to the portfolio's risk. Given high systematic risk, the expected rate of return of that security must be high enough to cover the risk of co-movement of the security's return

with that of the market portfolio. When the stock is priced based on the CAPM, it implies that stocks with the same systematic risk (beta) should have the same expected return. In practice, however, beta does not incorporate all the risk characteristics of the firm, and as a result, stocks with the same beta do not necessarily share the same actual return due to effects of firm specific characteristics. Consequently, it seems appropriate to investigate the riskiness of a security based on the total risk, incorporated both beta and nonsystematic risk.

Organization of the Study

This dissertation will be organized as follows. Chapter II examines prior research on the impact of merger on the riskiness of the firm. Chapter III examines the theoretical framework regarding the risk-return relationship, the components of risk, and the expectations of risk changes subsequent to merger. In chapter III, the limitations of the ex-post beta estimate are also critically analyzed in terms of methodological deficiencies. The Black-Scholes option pricing model is then suggested as a measure of the market's risk expectation. Empirical procedures will be discussed in chapter IV. Chapter V reports the empirical results, and chapter VI concludes the study.

CHAPTER II
REVIEW OF THE LITERATURE

Two general types of acquisitions are mergers and tender offers. A merger is an agreement between an acquiring firm and a target firm to combine into one economic unit under legal procedures. A tender offer is an offer to purchase a portion of the shares of the target firm at specified terms. Sometimes tender offers result in mergers when the acquiring firms acquire the remaining portion of the target firms after previous tender offers in order to gain full control. Tender offers have greatly accelerated since 1965.

There are two theories related to mergers. The first refers to the classical theory of growth maximization [Reid, 1968]. Mergers are made to maximize growth in sales or assets as well as to control a larger market share. This hypothesis is more likely applicable to conglomerate firms that are engaged in active acquisition programs. The second class of theories refers to the value maximization hypothesis. Finance and economics academicians have offered several justifications for value-maximizing mergers. Reviews of these merger motives can be found in Firth [1980], Copeland and Weston [1983] and Halpern [1983].

A set of economic justifications for value-maximizing mergers concerns synergy in which mergers result in economic gains. These gains can occur from economies of scale or economies of scope where average cost of production falls as output increase and expands up to some level. Another source of gain can be achieved through monopoly power.

That is, firms seeking an increase in market power via mergers would expect an increase in post-acquisition cash flows. Horizontal and vertical mergers appear to occur for these reasons.

Some researchers in finance attribute the increase in the value of the combined firm over the sum of the independent firms to financial synergy. Studies of financial synergy have been done in two areas: profitability and risk of merger firms. This chapter reviews literature on the impact of merger on equity risk as a primary concern and an overview of its impact on a firm's profitability.

Two approaches are employed in investigating the financial impact of merger: a firm-specific analysis and a market-based analysis. The firm specific analysis deals with an examination of the performance of mergers at the firm level. Statistical inferences are drawn from firm-specific data with respect to size, risk, and profitability of merger firms in order to discern motives and effects of merger. The analysis at a market level involves the linkage of market variables to the expectation of investors in the aggregate security market. If the market is efficient, the information anticipated by investors should be reflected in equilibrium prices. Consequently, the impact of merger is evaluated via linking the market price variables to the firm's performance.

The next section briefly overviews the impact of merger on the firm's profitability. Finally, the impact of merger on equity risk including beta risk, residual risk, and total risk will be discussed.

Effects of Merger on the Firm's Profitability

Studies of the statistical performance of conglomerate and nonconglomerate mergers focus on their operating characteristics (Reid [1968], Weston and Mansinghka [1971], Lev and Mandelker [1972]). The evidence shows that the conglomerate mergers outperform other mergers with respect to growth in size, but no distinctive performance is noted with respect to profitability.

Weston and Mansinghka [1971] used a sample of 53 conglomerates, while Lev and Mandelker [1972] used a sample of 69 large nonconglomerate mergers. Both studies employ control samples of non-merged firms. Lev and Mandelker also employ pretest and posttest analyses in order to compare the performance of acquiring firms before merger with that of the consolidated firms after merger. The results confirm the synergistic effect such that the profitability of the merged firms increases for most firms in the sample.

The problems inherent in the above studies are the result of self-selection bias. Merger firms may systematically differ from the nonmerger firms, and the long period of studies likely spans other confounding events that can affect the profit performance of the merger firms.

The market-based analysis aims at examining whether merger firms are value maximizers. The studies,[1] in general, evaluate the time series behavior of residual returns surrounding the events of merger

[1]For a comprehensive review of existing evidence on gains to shareholders of the merging firms, see Jensen and Ruback [1983]; and for evidence on a theory of mergers see Halpern [1983].

announcements or merger effective dates. The expectation of return models commonly employed are the single index market model, the two index model, and the CAPM model.

Studies of equity returns surrounding the merger dates report inconclusive results. The acquiring or bidding firms earn either normal (insignificant positive) returns (Hogarty [1970]; Mandelker [1974]; Langetieg [1978]; Asquith [1983]; Eckbo [1983]; Dennis and McConnell [1986]; Amihud, Dodd, and Weinstein [1986]) or significant negative abnormal returns (Dodd [1980], Firth [1980], and Eger [1983]). On the other hand, the target firms' shareholders appear to earn significant positive abnormal returns during the months before merger.

As for the announcement effects of mergers, the evidence indicates that shareholders of target firms realize large positive abnormal returns in completed takeovers while shareholders of the bidding firms earn only a small positive abnormal returns in successful mergers (Dodd [1980]; Asquith [1983]; Asquith, Bruner, and Mullins [1983]; and Malatesta [1983]).

Jensen and Ruback [1983] conclude that the gain created by mergers do not appear to come from the creation of market power, but rather the competition among managerial teams for the rights to manage corporate resources. According to agency theory, a firm is viewed as a nexus of contracts among agents. Shareholders are the principals who bear risk, and managers are agents who manage resources. If the management of the firm does not manage resources in an efficient manner, the shareholders may value the firm at a low price. An undervalued firm makes it likely for competing outside managements to acquire the rights to control the

firm. Fama [1980] refers to an outside takeover as a device for monitoring the management action or a full ex-post settling up.

Total dollar value gains from mergers that account for the size of merger firms are analyzed by Malatesta [1983] and Bradley, Desai, and Kim [1982]. A significant positive total gain was found for both bidding and target firms during the announcement months.

Effects of Merger on the Firm's Equity Risk

The impact of merger on a firm's risk characteristics was examined at the firm level in few studies. Reid [1968, 1971] concerns the growth maximization motive of merger. His hypothesis that conglomerates outperformed other mergers with respect to higher growth in sales, assets, and employees was not rejected. Melicher and Rush [1974] examined the performance of conglomerates versus nonconglomerates in the same industry during 1960-1969. Conglomerates were characterized as being larger, seeking more profitable targets, and utilizing the acquired firms' latent debt capacity than nonconglomerates.

Smith and Schriner [1969] examined the risk reduction hypothesis, but did not find evidence that conglomerates were more successful in diversifying risk when compared with the portfolio performance of investment companies (portraying self-diversification). In contrast, Westerfield [1970] indicated that conglomerates have lower systematic (beta) risk, although the difference was not as much as that between mutual funds. Melicher and Rush [1973] examined both the operating and market-related characteristics of 45 conglomerate mergers in comparison to 45 nonconglomerates. Conglomerates were found to be more levered

with higher levels of systematic risk and insignificantly higher total risk, but that both groups had about the same level of returns. This evidence was also supported by Smith and Weston [1977]. Smith and Weston replicated and extended the Melicher and Rush [1973] study, using 38 conglomerates, 104 mutual funds, 17 closed-end investment companies, and 35 nonconglomerates. The systematic risk was significantly higher for the conglomerate sample in relative to the nonconglomerate sample during both periods before and after merger.

In order to eliminate the effect of nonmerger-related factors, Haugen and Langetieg [1975] tested for synergism in mergers using a matched-pair nonmerger sample compared with the treatment sample of 59 nonconglomerate mergers. The risk of a weighted portfolio of acquirers and targets before merger was compared with that of the combined firms after merger. Little evidence of synergy was found since the change in risk was not significantly different from that of the control group. Haugen and Langetieg then concluded that an individual could do as well by forming a portfolio of two stocks as buying stocks in a company involved in merger. A similar finding of merger effect on beta was also reported in Joehnk and Nielsen [1974].

In a later study, Langetieg, Haugen, and Wichern [1980] examined 149 large mergers involved with an all-common exchange. Four hypotheses tested were the portfolio effect, the price-earning effect, the risk reduction effect, and the leverage effect. A comparison between the risk measures of consolidated firms and the combined portfolio of merging firms's risk was performed. The evidence showed that merger tended to be associated with an unexpected increase in the levels of

both systematic risk, total risk, and diversifiable risk for the consolidated firm. The result was inconsistent with other merger impact studies that viewed merger as risk reducing. The risk increases were attributed to an increase in leverage and an aggressive management in the acquiring firm. It should be noted that the direction of changes in risk was unpredictable. The inability to distinguish the observed changes in equity risk of the merger firms from the control firms might be attributed, not to merger, but to the instability associated with the risk variable.

There appears to be an offsetting effect of risk changes. Gahlon and Stover [1979] investigated mergers for 37 conglomerates and 34 nonconglomerates for the periods 1960-1966 and 1969-1975. An expectation model of return-adjusted beta was regressed on financial leverage and diversification measures. Financial leverage and beta were found to be significantly different between conglomerates and nonconglomerates. The hypothesis stating that the diversification effects on beta were partially offset by the greater risk inherent in the use of increased debt level was not rejected. Moreover, the significant variables affecting return-adjusted betas were (1) volatility of operating earnings, and (2) the degree of financial leverage. Gahlon and Stover finally concluded that "what conglomerates may have gained in terms of risk reduction from their diversification activity, they may have lost because of the higher risk resulting from the utilization of their increased debt capacity [p.1000]." Higgins and Schall [1975] and Kim and McConnell [1977] also suggested the "coinsurance hypothesis" that explained the increase in leverage after conglomerate mergers. This

issue will be discussed in chapter III.

All prior studies on the risk impact of merger failed to detect the change in risk due to the operating risk effects (e.g., a reduced pressure of competition, an increase in market power, or an increase in fixed charges causing changes in the firm's operation). No distinction has been made due to the separate effects of financial risk, operating risk, and market risk. Only the overall risk effect inherent in the market beta risk and the total risk were examined. Table 2.1 provides a summary of prior research evidences of the merger impact on equity risk. Table 2.2 presents the overall conclusion of findings on separate risk variables.

TABLE 2.1

Evidence from Studies of Merger Impacts on Equity Risk

Studies	Period	Sample	Results
Firm-specific performance			
Reid [1971]	1960	Conglomerates	Higher growth, but no distinction in profitability.
Melicher and Rush [1974]	1960-1969	61 conglomerates and 71 nonconglomerates.	No distinction in profitability of conglomerates. Conglomerates have larger size and higher leverage.
Market-based performance			
Smith and Schriner [1969]	1953-1967	19 conglomerates and 8 investment companies.	Investment companies are more efficient in portfolio diversification.
Westerfield [1970]	1954-1968	Conglomerates and mutual funds.	Conglomerates reduce beta risk. Conglomerates are less diversified than mutual funds.
Weston and Mansinghka [1971]	1960-1969	Conglomerates vs. mutual funds.	Conglomerates have higher return on assets and beta.
Melicher and Rush [1973]	1965-1971	45 conglomerates vs. matched-pair nonconglomerates.	Conglomerates have higher beta and total return variability, but not higher returns.

TABLE 2.1 -- Continued

Studies	Period	Sample	Results
Haugen and Langetieg [1975]	1951-1968	59 nonconglomerates and a control sample before vs. after merger.	Increase in unsystematic risk after merger. Insignificant differences in beta and total risk. Little evidence of synergism.
Smith and Weston [1977]	1964-1973	38 conglomerates vs. 104 mutual funds,17 closed-end companies, and 35 nonconglomerates.	Return-adjusted beta is higher in conglomerates. High beta conglomerate firms perform better during rising markets, but worse during flat markets.
Gahlon and Stover [1979]	1960-1966, 1969-1975	37 conglomerates and 34 nonconglomerates.	Financial leverage and beta are significantly higher for conglomerates. Leverage and volatility of operating earnings are significant factors for beta.
Langetieg, Haugen, And Wichern [1980]	1951-1968	149 mergers and a control non-merger sample.	Increases in total risk, beta, and unsystematic risk for merger firms.

TABLE 2.2

Overview of Merger Impacts on Equity Risk

Variable	Increase	Decrease	No difference
Total risk	Melicher & Rush (MR) [1973]		Smith & Schriner [1969]
	Langetieg, Haugen & Wichern (LHW) [1980]		Haugen & Langetieg (HL) [1975]
Beta	MR [1973]	Westerfield [1970]	Joehnk & Nielsen (JN) [1974]
	Smith & Weston (SW) [1977]		HL [1975]
	Gahlon & Stover [1979]		
	LHW [1980]		
Nonsystematic risk	HL [1975]		
<u>Others</u>			
R^2	LHW [1980]		JN [1974]
Leverage	Lewellen [1971]		
	MR [1974]		
	Kim & McConnell [1977]		
	Gahlon & Stover [1979]		

CHAPTER III
THEORETICAL CONSIDERATIONS

An Overview

This chapter offers an overview of two valuation models, namely, the capital asset pricing model (CAPM) and the option pricing model (OPM). The components of risk are then derived from combining the CAPM and the fundamental valuation models of Miller and Modigliani.

The distribution of stock returns or price changes is generally defined in terms of expected return and variance or (standard deviation). Risk averse investors, who prefer more wealth for less risk, select their portfolio based on these two parameters. Given the mean-variance criteria, the capital asset pricing model (CAPM) was developed by Treynor [1961], Sharpe [1964], Lintner [1965], and Mossin [1966], following Markowitz's [1952,1958] portfolio theory.

If capital markets are perfect, the risk of a well-diversified portfolio reflects mainly the covariances of the individual asset returns with returns of the market portfolio. The CAPM gives the equilibrium relationship of this risk (called beta) and the expected return. However, if securities markets are imperfect (e.g., due to high transaction costs), then it would not be feasible to hold a well-diversified portfolio. In this case the total variability of asset returns should be taken into account. Total risk of the stock is a major determinant of equilibrium asset value in the OPM.

Risk-Return Relationship

Two major theories of finance that offer the equilibrium valuation of asset prices are (1) the capital asset pricing model (CAPM) and (2) the option pricing model (OPM). These two models provide the equilibrium value of a security as a function of the risk involved. Certain assumptions are necessary for these models.

The Assumptions

The CAPM and the OPM were derived given the following assumptions regarding markets, investors, and the firm setting.[1]

1. The markets. Capital markets are assumed to be perfect in the sense that all assets are infinitely divisible; information is costlessly available to all investors; there are no transaction costs or taxes; and the markets are composed of many buyers and sellers who are price-takers.

2. The investors. All investors are assumed to be risk-averse and expected utility maximizers. That is, each individual has a monotonically increasing and strictly concave utility function. Moreover, they are assumed to have homogeneous expectations about the probability distribution of firm values and security prices.

3. The firms. It is assumed that bankruptcy or reorganization costs are negligible. The firms as well as individuals can lend or borrow at the same riskless interest rate that is known and assessed to

[1]The derivation of the CAPM can be found in Sharpe [1963, 1964], Lintner [1965], Mossin [1966], and Fama and Miller [1972]. The derivation of the OPM is in Black and Scholes [1973] and Merton [1973].

be constant through time. The distribution of the firm's security price is log-normal. The variance of the rate of return on the firm asset is constant. Finally, there is no restriction on short-selling, and free use of all proceeds is allowed.

The CAPM

The CAPM theory offers an analytic explanation of asset prices. Asset risk depends not on the specific individusl risk of the asset, but rather on the relationship of asset to the overall market. The simple form of the CAPM states the equilibruim expected returns on asset j, $E(R_j)$, as follows:

$$E(R_j) = R_f + [E(R_m) - R_f]\ \beta_j$$

where R_f is the riskfree rate of interest, $E(R_m)$ is the expected return on the market's efficient portfolio, and $\beta_j = cov(R_j R_m)/\sigma^2(R_m)$, the covariance between the return on asset j and the market portfolio return standardized by the variance of the market return.

In this context, total risk (variance) is divided into two components.

Total risk = Systematic risk + Nonsystematic risk
(nondiversifiable) (diversifiable)

If capital markets are perfect, potential gain would accrue from diversification. As the number of assets in the portfolio gets larger, the nonsystematic risk becomes negligible. Thus, only systematic risk (beta) is relevant to investment decisions.

In summary, CAPM serves a dual role. First, it explains a set of equilibrium asset prices that affect allocation of resources between a riskfree asset and a mean-variance efficient market portfolio. Second, a linear relationship between expected investment return and systematic risk (beta) implied in the security market line provides a benchmark for security performance. If the CAPM is valid and if markets are efficient, the expected return on an asset should fall on the security market line. Thereby, it enables individuals to select portfolio in order to attain their consumption choices and risk preferences.

The Problems of beta predictions

According to the CAPM, beta is a sufficient security-specific variable in determining expected return. Consequently, several studies (for example, Beaver, Kettler, and Scholes [1970]; and Hill and Stone [1980]) attempt to find approaches to predict beta. Two sources of information have been examined: (a) the ex-post distribution of beta and (b) the firm-specific information from the accounting system.

Accounting variables have been used jointly with market variables for investors' evaluation of the firm performance. Prior research by Beaver, Kettler, and Scholes [1970] report significant correlations between accounting risk surrogates and the beta risk. The accounting risk measures are employed as instrumental variables in forming a beta approximation. Bowman [1979] also found that leverage and the accounting-based beta accounted for about 70 percent of the market beta measure. Hill and Stone [1980] reported that both changes in financial structure and systematic operating risk were significant determinants of

changes in market betas. However, the superiority of accounting risk prediction over market beta prediction is doubtful since the use of estimated beta involves some problems.

Three beta prediction problems arise. First, the mapping of ex-post estimates to ex-ante prediction presumes a stationary distribution of beta. Vasicek [1973] and Blume [1975] noted this problem and, after having developed the statistical adjustments for beta, found beta to have a mean reverting tendency. As such, the inferior predictive ability of beta estimated from market variables might be attributed to its instability (this issue is extensively discussed in Eskew [1979] and Elgers [1980]).

Second, the validity of CAPM was criticized by Roll [1977] and Ross [1978]. According to the CAPM, the expected return of an asset was linearly related to its beta, provided that the beta was calculated using a mean-variance efficient portfolio as the proxy for the market index. That is, the market portfolio must be on the efficient frontier of minimum variance portfolios. Consequently, Roll stated that tests of hypothesis about abnormal return did not provide a test of the validity of CAPM, but a test of whether the market index used was mean-variance efficient. The choice of market index will, therefore, affect the ranking of security performance in portfolio selection. An evaluation of the sensitivity of the market index proxies is also discussed in Green [1986]. In addition, the true market portfolio is impossible to observe because it contains all assets, including those which are nonmarketable (e.g., human capital).

The third problem of using beta prediction relates to the improper specification of CAPM. One such misspecification discussed in Banz [1981] and Reinganum [1981] concerns a "size effect" on stock returns. Basu [1977,1981] also studied both the size and the price-earning ratio dichotomy on stock returns. Other possible sources of misspecification are related to dividends (Litzenberger and Ramaswamy [1979]) and the "January effect" (Roll [1982]). Thus, beta itself may not account for all the systematic risk of the firm. Other factors affecting the specification of systematic risk ought to be taken into account. Such problems do not exist in the option pricing model (OPM) that applies ex-ante measures of total risk of stock returns into its function.

The OPM

Unlike the CAPM, the option pricing model (OPM) yields a valuation of an asset as a contingent claim, in relative to the value of another asset. Most prevalent is a call option that gives the holder the right to buy or sell an underlying asset at some specified price. The functions of OPM have been developed first by Black and Scholes [1973] who assumed a geometric Brownian motion of stock returns. A further refinement is the diffusion model by Rubinstein [1980], the pure jump model by Cox and Ross [1976], the diffusion-jump model by Merton [1976], the compound option model by Geske [1979], and the constant elasticity of variance model by Cox [1975]. The evidence on testing call option models shows that the Black-Scholes model performs relatively well, especially for at-the-money options (see a review by Galai [1982]).

According to the Black-Scholes [1973] model, the value of an option is determined as a function of the current stock price, the exercise price, the time to maturity, the instantaneous rate of return, and the variance of stock returns. The call value increases with the increase in stock price, interest rate, time to expiration, or stock volatility. The value decreases as the exercise price increases. The value of an option can never be negative. If the stock price falls below the exercise price at the expiration date, the call option is worthless. The lower bound of a call option is then Max (0,S-X), where S is the stock price and X is the exercise price. The call price can never exceed the stock price. When the stock price becomes large, the option price approaches the stock price less the present value of the exercise price. Of all the option value determinants, only the stock return variance is not observable. Therefore, the expectation of stock variability has to be employed.

The Black-Scholes model assumes no dividend for the underlying asset. Dividends were later generalized and incorporated into the model by Merton [1973]. The call option is thereby priced as follows:

$$C = e^{-dt} SN(d_1) - e^{-rt} Xe^{-rt} N(d_2)$$

where N(.) is the cumulative standard normal distribution,

$$d_1 = \frac{\ln(S/X) + [r-d+(1/2)\sigma^2]t}{\sigma \sqrt{t}} \text{ , and}$$

$$d_2 = d_1 - \sigma \sqrt{t} \text{ ,}$$

where S is the current value of the underlying asset, X is the exercise price of the option, d is the dividend yield of the underlying asset,

t is the time to maturity of the option, and σ^2 is the instantaneous variance of returns on the underlying asset.

The call option function also provides a particular insight into the valuation of debt and equity of a company. The equity of a firm can be viewed as a call option on the total value of the firm's assets with an exercise price equal to the face value of the debt and an expiration date equal to the maturity date of debt.

The Components of Equity Risk

In this section, the capital structure theory is generalized to derive the components of total equity risk. The Miller and Modigliani (MM) irrelevance proposition is used jointly with CAPM to partition the components of equity risk. The theory of capital structure implies that the expected return on the firm asset is the weighted average of the instantaneous expected rate of returns on its securities (debt and equity). That is

$$R_v = \frac{S}{V} R_s + \frac{D}{V} R_d \qquad (3.1)$$

where V, S, D are the market value of firm, equity, and debt, respectively; and R_v, R_s, R_d are the rates of returns of firm, equity, and debt, respectively.

From equation (3.1), it follows that (Modiagliani and Miller [1963], p.439)

$$R_s = R_v + (R_v - R_d) \frac{D}{S} \qquad (3.2)$$

This is equivalent to the MM's Proposition II where the expected yield of stock is equal to the capitalization rate of a pure equity stream, plus a premium for financial risk which is equivalent to the difference between the pure equity capitalization rate and the yield on debt weighted by the leverage ratio. Rubinstein [1973] and Galai and Masulis [1976] interpret the first term on the right hand side of equation (3.2) as the expected rate of return for the operating risk and the second term as the financial risk of a levered firm borne by its shareholders.

From equation (3.2) the variance of return relationship can be stated in terms of variance as follows:

$$\sigma_S^2 = \sigma_V^2 \left(1+\frac{D}{S}\right)^2$$

or, in standard deviation terms (Chen [1985]),

$$\sigma_S = \sigma_V \left(1+\frac{D}{S}\right) = \sigma_V + \frac{D}{S}\sigma_V$$

It can be seen that the equity risk of the levered firm increases as debt is introduced into the capital structure.

Linkage between Market variables and Firm-specific Variables

Given MM's Proposition I (the "irrelevance" theorem), the total market value of a firm is independent of its capital structure. The firm value is given by capitalizing the expected stream of operating earnings at a discount rate appropriate for its risk class. That is (Modigliani and Miller [1958], p.268)

$$V = S + D = \frac{E(P)}{R_V}, \text{ and thus}$$

$$R_V = \frac{E(P)}{V}$$

$$\sigma_V = \frac{\sigma_P}{V}$$

where E(P) is the expected operating earnings of the firm.

As such the equity risk can be defined in terms of the firm's earning volatility adjusted for financial leverage. That is

$$\sigma_S = \frac{\sigma_P}{V}\left(1 + \frac{D}{S}\right) = \frac{\sigma_P}{V} + \frac{\sigma_P}{V}\frac{D}{S} \qquad (3.3)$$

Given perfect and competitive capital markets and that the equilibrium value of a firm can be identified by the CAPM framework, Hamada [1969, 1972] has developed the firm value as the certainty equivalent function of expected earnings capitalized by the riskfree interest rate.[2]

$$V_j = \frac{E(P_j) - \lambda \, Cov(P_j P_m)}{R_f} \qquad (3.4a)$$

or

$$= \frac{E(P_j) - \lambda \, \sigma(P_j) \, \sigma(P_m) \, \rho(P_j P_m)}{R_f} \qquad (3.4b)$$

where $\lambda = [E(P_m) - R_f V_m)] / \sigma^2(P_m)$ is the market price of risk, V_m and P_m are, respectively, the total value and earnings of the market portfolio of risky securities, and R_f is the riskfree interest rate. Chen [1985] combined the CAPM with the MM propositions in deriving the total risk of firm. For the purpose of this thesis, Chen's approach will be used to partition the components of equity risk by firm-specific variables.

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[2]Necessary assumptions that link MM's fundamental value theory with the risk-return relationship of CAPM were provided in Hamada [1969, pp. 14-15].

From equations (3.3) and (3.4), the equity risk can be expressed as a function of financial risk, operating risk, and the covariability of firm earnings and market portfolio earnings.

$$\sigma(S_j) = \frac{\sigma(P_j)\ R_f}{E(P_j) - \lambda\ Cov(P_j P_m)} \cdot \left(1 + \frac{D_j}{S_j}\right) \tag{3.5a}$$

or equivalently, in terms of the correlation coefficient:

$$\sigma(S_j) = \frac{\sigma(P_j)\ R_f}{E(P_j) - \lambda\ \sigma(P_j)\ \sigma(P_m)\ \rho(P_j P_m)} \cdot \left(1 + \frac{D_j}{S_j}\right) \tag{3.5b}$$

Dividing both numerator and denominator of equation (3.5b) by $E(P_j)$, the above function can be expressed as

$$\sigma(S_j) = \frac{\frac{\sigma(P_j)}{E(P_j)} \cdot R_f}{1 - \lambda\ \frac{\sigma(P_j)}{E(P_j)}\ \sigma(P_m)\ \rho(P_j P_m)} \cdot \left(1 + \frac{D_j}{S_j}\right) \tag{3.6}$$

<u>Financial risk</u>. Financial risk is the additional risk the shareholders bear as a result of introducing debt in capital structure. This is the weight represented by the component of $\left(\frac{D_j}{S_j}\right)$ in equation (3.6).

The change in equity risk with respect to the financial leverage depends on the earnings volatility per unit of the firm value. Since both the earnings volatility and the firm value are positive, the change in equity risk due to the financial leverage is also positive. This is represented as follows:

$$\frac{\partial \sigma(S_j)}{\partial \left(\frac{D_j}{S_j}\right)} = \frac{\sigma(P_j)}{V_j} > 0.$$

Operating risk. Operating risk or business risk is the riskiness of the firm's assets if the firm has no debt. Brigham and Gapenski [1987] define it as "the uncertainty inherent in projections of future operating income, or earnings before interest and taxes (EBIT)." From the above equation, operating risk is denoted by the standard deviation of operating earnings $[\sigma(P_j)]$.[3] Furthermore, standardizing the operating earnings volatility by its mean yields the coefficient of variation of operating earnings $[CV(P_j)]$. This variable, which is a proxy for operating risk, reflects the management decisions concerning the production and investment activities of the firm.

As the coefficient of variation of operating earnings increases, so does the equity risk.

$$\frac{\partial\,\sigma(S_j)}{\partial CV(P_j)} = (1 + \frac{D_j}{S_j}) \frac{R_f}{[1 - \lambda \frac{\sigma(P_j)}{E(P_j)} \sigma(P_m)\ \rho(P_jP_m)]^2} > 0.$$

Correlation of earnings $[\rho(P_jP_m)]$. The third component of equity risk is the correlation between the firm's earnings and the earnings of a market portfolio. This is also a component of an accounting beta $[\beta^A = \sigma(P_j)\sigma(P_m)\rho(P_jP_m)/\sigma^2(P_jP_m)]$ as described in Beaver, Kettler, and Scholes [1970] and Bowman [1979]. This correlation provides management with an indicator for policies to insulate the firm's earnings from economy wide events. A higher degree of correlation means a larger

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[3]Rubinstein [1973, p.178] partitioned the expected return of equity into three components, including risk free, operating risk, and financial risk. The operating risk was a function of operating leverage, the influence of economy-wide events on output, and the standard deviation of output per dollar of assets which was interpreted as a measure of the uncertainty of operating efficiency.

component of the firm's earnings fluctuate with market movement. In other words, the firm has a higher degree of nondiversifiable risk, and has little gains from diversification. As long as the residual or diversifiable risk is positive, there will be further gains from diversification. Therefore, if the management wants to reduce risk, it can do so by diversifying the company and reducing the diversifiable risk.

As the correlation between the firm's and the market portfolio's earnings increases, the equity risk increases since the market price of risk is positive. It follows that

$$\frac{\partial\sigma(S_j)}{\partial\rho(P_jP_m)} = (1 + \frac{D_j}{S_j}) \left[\frac{\sigma(P_j)}{V_j}\right]^2 \left[\frac{\sigma(P_m)\ \lambda}{R_f}\right] > 0.$$

Figure 3.1 shows the relationship between the equity risk and the three risk components with respect to the level of financial leverage of the firm.

When the firm bears no financial risk, the equity risk still reflects the operating risk inherent in the firm's activities represented by the earnings variability. Once leverage is introduced into the firm capital structure, the equity risk increases as a function of the proportion of debt to equity. The change in equity risk would be higher if the firm has higher correlations of the firm's earnings with the market portfolio's earnings.

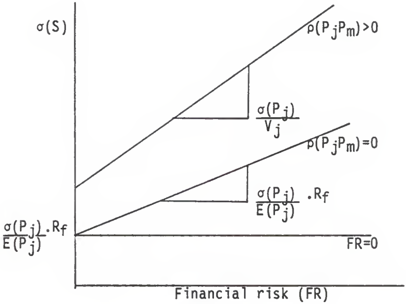

Figure 3.1 The relationship between equity risk and risk components

Expected Changes in Risk Subsequent to Merger

Investors should expect that the risk will decrease subsequent to conglomerate merger due to portfolio diversification. In contrast, the coinsurance theory of merger predicts that, as a result of wealth transfer between the bondholders and the shareholders, equity risk may increase due to the protective action taken by the constituent shareholders. The diversification and coinsurance theories are discussed below.

Diversification Effect

Following Markowitz's [1952,1959] portfolio theory, the diversification inherent in a conglomerate merger has been examined by Gort [1969], Smith and Schreiner [1969], and Levy and Sarnat [1970].

The theory advocates that the total postmerger risk of the two combined firms can be reduced if the returns of those constituent firms are less than perfectly correlated.

A merger is regarded as the legal combination of the shares of two firms into the entity of the surviving firm. If the merging firms have perfectly correlated returns, and if there is no synergies, the postmerger distribution of the rate of return will be the same as of the acquiring firm. However, if the two merging firms have different distributions (as shown in figure 3.2 [a]), then the postmerger return distribution will be different from that of the acquirer and will depend on the covariance between those two firms' returns (figure 3.2 [b]).

The intuition of the illustration can be discussed by the properties of random variables. Since earning streams are random variables, the expected postmerger earnings in the new firm would be the weighted average of the earnings of the two merging firm. That is:

$$E(P_{ij}) = W_i \, E(P_i) + W_j \, E(P_j) \qquad (3.7).$$

The post-merger earnings variance becomes

$$\sigma^2(P_{ij}) = W_i^2 \, \sigma^2(P_i) + W_j^2 \, \sigma^2(P_j) + 2W_iW_j \, \sigma(P_iP_j) \qquad (3.8).$$

The relation (3.8) can be stated alternatively as follows.

$$\sigma^2(P_{ij}) = W_i^2 \, \sigma^2(P_i) + W_j^2 \, \sigma^2(P_j) + 2W_iW_j\sigma(P_i)\sigma(P_j)\rho(P_iP_j) \qquad (3.9).$$

The postmerger earnings variability is thus dependent upon the pre-merger earnings variability of each individual firm and the degree of correlation between their earnings' streams. Two extreme degrees of correlation can be illustrated by two cases:

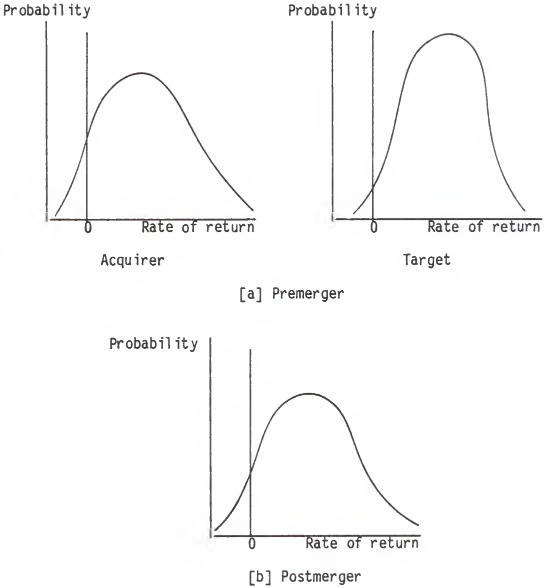

Figure 3.2 The probability distributions of hypothetical merger firms.

Case 1. $\rho(P_i P_j) = 1.$

$$\sigma^2(P_{ij}) = [W_i\ \sigma(P_i) + W_j\ \sigma(P_j)]^2$$

or stated in the standard deviation term as

$$\sigma(P_{ij}) = W_i\ \sigma(P_i) + W_j\ \sigma(P_j)$$

which is simply the weighted average of the standard deviations of earnings of the merging firms.

Case 2. $\rho(P_i P_j) = 0.$

$$\sigma(P_{ij}) = [W_i^2\ \sigma^2(P_i) + W_j^2\ \sigma^2(P_j)]^{1/2}$$

Since $W_i+W_j=1$, case 2, being a convex function, is always less than case 1. Consequently, as long as the degree of correlation between the premerger firms' earnings is less than perfect, the postmerger earnings volatility will always be less than the two firms' risk when independently combined.

High diversification firms, having the returns correlation close to zero, can be found in cases of conglomerate mergers where the combining firms have unrelated activities. On the contrary, horizontal and vertical mergers would have a lower diversification degree with the correlation between both firms' earnings close to one.

Coinsurance and Leverage Effects

The coinsurance concept of merger has been examined extensively by Lewellen [1971], Rubinstein [1973], Higgins and Schall [1975], Galai and Masulis [1976], Kim and McConnell [1977], Lee [1977], Scott [1977], and Stapleton [1982]. Two major conclusions of this line of research are (1) that a conglomerate merger of two firms that have positive probability of loan defaults would create a coinsurance impact against

default and can generate both cost and benefit to equity holders; and (2) that if the market is perfect and competitive, conglomerate merger will not affect the value of the constituent equity.

In the merger case, the new firm remains liable for the acquiring firm's debt and, in addition, assumes liability for the outstanding debt of the acquired firm. The combined firm is able to draw more flexibly on the cashflow from new combined cashflow streams in order to meet the critical obligations of the weaker firm. As a result, merger coinsurance implies two sources of gain: (1) a reduction in the risk of bankruptcy and costs, and (2) an increase in debt capacity that can reduce the cost of capital. Lewellen suggests that the increased debt capacity as well as a tax subsidy from interest provides an opportunity for increasing the equity value. This is true when bankruptcy is costly and the firm cannot utilize the debt capacity freely. Rubinstein [1973] states that the merger that reduces bankruptcy costs will benefit both shareholders and bondholders. However, the wealth transfer may result from the increased bond value. Galai and Masulis [1976] argue that the risk diversification effect of merger implies a wealth transfer from shareholders to bondholders. Merger reduces financial risk to creditors of the postmerger firm and consequently increases the bond value. If bankruptcy is costless, then any increase in debt value will be offset by a decrease in equity value, and hence, there is no increase in firm value (Higgins and Schall [1975]). As the equity value falls, shareholders can protect themselves in one of two ways. First, they can call existing debt at the premerger price and issue the new debt at a higher price (Higgins and Schall method). Second, they can increase financial

leverage relative to the premerger financial leverage of combining firms up to the point where the postmerger default risk is increased sufficiently to cancel any wealth transfers from shareholders to bondholders (Kim and McConnell method).

Empirical evidence (Weston and Mansinghka [1971] and Shrieves and Parshley [1984]) found that merger was related to incentives to increase financial leverage. Choi and Philippatos [1983] also clarified that the merged firm that could not borrow more (due to high premerger leverage) might provide little incremental debt capacity. In contrast, the merged firm with low premerger leverage is expected to have higher leverage after merger. As the combined firm borrows more as a result of increased debt capacity due to merger, a benefit of tax saving will result from the interest payments on the additional borrowing. Investors of the merged firm can anticipate the extent of potential increase in debt capacity after the merger announcement. Consequently, the postmerger stock prices should reflect the invesotrs' expectations.

In summary, higher financial leverage reflects higher equity risk. Accordingly, if the firm retains its leverage level at the premerger level, the equity risk is expected to reduce as an effect of diversification. Nevertheless, an increase in leverage emanating protective actions by shareholders may explain the increase in equity risk after merger. The diagram of merger coinsurance impacts is shown in figure 3.3.

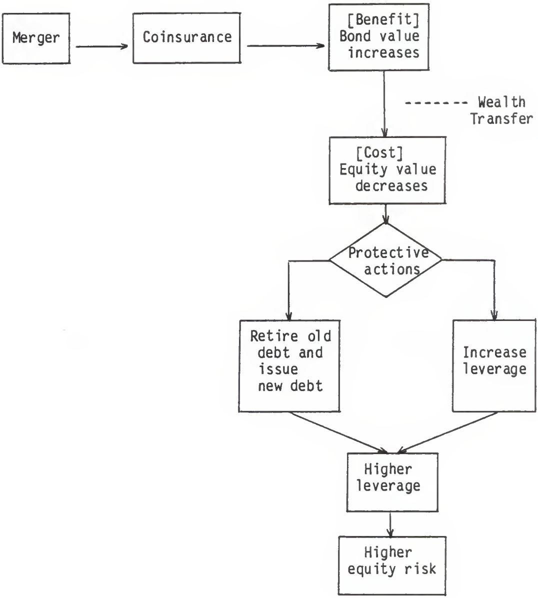

Figure 3.3 Diagram of the coinsurance impact on leverage.

Operating Synergy Effect

Haugen and Langetieg define synergism [1975, p.1004] as one "taken to be evidenced by properties of the underlying distribution of rates of return to stocks of formally united firms which differ from those which the portfolio investor can obtain through informal combination." An informal combination means an informal purchase of both companies' shares by the portfolio investor.

Two major operating synergies are (1) that the diversified and horizontal mergers may make new entry into new product lines that would change the level and variability of the firm's profitability; and (2)that the vertical merger may reduce the risk of fluctuations in the supply and price of raw materials.

An increase in market power (from horizontal or conglomerate mergers) and a decrease in demand on input as well as input price fluctuations (from vertical merger) result in a reduction in earnings variability of the firm. Since operating risk (sometimes called business risk) is an uncertainty related to the earnings generating power of a firm, a decrease in earnings variability reduces the firm's operating risk.

Lev [1974] has suggested a measure termed operating leverage as a measure of the riskiness of the firm's equity returns. The firm's operating leverage is defined as the ratio of the fixed to variable costs. A high operating leverage implies that a relatively small change in output levels or sales may result in a higher change in operating income.

Given the firm's earnings before interest and taxes is defined as

$$P_i = (S_pQ)_i - (V_cQ)_i - F_i \qquad (3.10)$$

where S_p = average sale price per unit of the product,

V_c = average variable costs per unit of the product,

Q = demand, being a random variable, and

F_i = total fixed costs of the firm i.

Differentiating (3.10) with respect to Q_i yields

$$\frac{\partial P_i}{\partial Q_i} = S_{pi} - V_{ci}$$

Considering two firms, i and j, where firm i has a higher operating leverage; the variable cost of firm i will be less than that of firm j. That is $V_{ci} < V_{cj}$. Accordingly, the derivative of firm i's earnings with respect to demand will be larger than that of firm j's earnings. In other words, the higher the operating leverage (i.e., the relative share of fixed costs), the higher the volatility of the operating earnings with respect to demand fluctuations and, hence, the higher the operating risk.

When mergers result in changes in operations that might reduce fixed charges incurred by the postmerger firm, the volatility of operating earnings will decrease. Since the volatility of operating earnings is related to the equity risk by (3.6), the lower the operating leverage the lower the operating risk as well as total equity risk.

In summary, this chapter offers the decomposition of equity risk in to three components: (1) financial risk, (2) operating risk, and (3) correlation of firm's earnings with market's earnings. Three effects of merger on changes in equity risk are discussed. First, the

diversification effect asserts that as long as the market earnings correlation is less than one (that is, gain on diversification exists), the equity risk of the merged firm will be less than the equity risk of the premerger acquirer firm. Second, the leverage effect predicts the risk changes in the same direction of potential changes in leverage. Finally, the operating synergy effect posits that the equity risk of the merged firm postmerger increases (decreases) if the operating risk increases (decreases).

Table 3.1 summarizes the hypothetical expectations of changes in equity risk with respect to the effects of diversification, financial leverage, and operating synergies.

TABLE 3.1

Expectations of Risk Changes Subsequent to Merger

Effects	Conditions	Expected Risk Changes
Diversification Effect	$\rho(P_i P_j) < 1$	$R_m < R_a$
Leverage Effect	Leverage increases	$R_m > R_a$
	Leverage decreases	$R_m < R_a$
Operating Synergy Effect	Operating risk increases	$R_m > R_a$
	Operating risk decreases	$R_m < R_a$

Note: R_m -- Risk of the merged firm after merger
R_a -- Risk of the acquirer firm premerger

CHAPTER IV
EMPIRICAL CONSIDERATIONS

Two alternative approaches are considered for examining the effect of merger on equity risk: the ex-ante measurement of risk utilizing the implied standard deviation (ISD) generated from the option pricing model (OPM) and the ex-post measurement of risk using estimates based on the historical time series of returns. The primary concern of this study is to see how well the ex-post realization of changes in equity risk is a proxy for the ex-ante risk estimate (ISD) as a result of merger. Thus far, the understanding of the risk-generating process in capital markets is minimal. Consequently, understanding the relationship between alternative estimates of risk from the market and the firm-specific data would be useful for investors.

A secondary purpose of study is to investigate the explanatory power of accounting determinants of equity risk changes. At the firm level, the accounting risk variables are indicators of the management's effort to maximize shareholders' wealth. For example, a higher debt to equity ratio may indicate incremental bankruptcy risk borne by shareholders. At the investor level, the knowledge of the relationship between accounting risk and market variables should assist in the prediction of risk measures at future dates and the consequent informed portfolio selection.

Implied Standard Deviation

As mentioned earlier, Merton's generalization of the Black-Scholes (B-S) model identifies a call price as a function of six variables: the stock price, the exercise price, the time to maturity of the option, the riskfree interest rate, the dividend yield, and the instantaneous variance of stock returns. Of these six variables, only the variance of the rate of return is not directly observable. It has to be imputed from the available market data. A basic assumption of the B-S model is that the standard deviation of the underlying stock return is known and constant through time. A number of researchers have found that the distribution of price changes is fat-tailed and skewed (Officer [1972], Praetz [1972], Clark [1973], Epps [1976], and Westerfield [1977], for example). Furthermore, it has been found that the return distributions change over time (Rosenberg [1973], Blattberg and Gonedes [1974], Black [1975], Latane and Rendleman [1976], Christie [1982], among others). The calculation of the call price using the historical standard deviation of returns seems to introduce a biased estimate. Prior research on estimating the implied standard deviation found that the actual (ex-post) standard deviation of the stock return over the life of the option seems to explain call prices better than the historical standard deviation. Consequently, it seems appropriate to use the implied standard deviation (ISD) imputed from the option pricing model as a determinant of future return volatility.

Prior Research on ISD

Latane and Rendleman [1976] initially suggested the use of standard deviation of returns implied by the Black-Scholes model to estimate the equity risk. The ISD was applied to identify over-priced and under-priced options in forming hedged portfolios. Using the weighted average ISDs estimated from closing options and stock prices, they found that the estimated ISDs were superior to standard deviation of returns estimated from historical time series. The results were confirmed by Chiras and Manaster [1978]. Chiras and Manaster used Merton's generalization of the Black-Scholes model to calculate implied variances. The implied variances were found to be better predictors of future stock return variances than those obtained from past stock price data. They also examined the information content of option prices. The trading strategy based on the implied variances produces abnormally high returns, which is inconsistent with the efficient market hypothesis. Schmalensee and Trippi [1978] conducted the same approach, but used at-the-money options based on the closing option and stock prices. They revealed that the volatility over time derived from the aggregate market expectation contains nonrandom elements, indicating evidence for market inefficiency. A weak relationship was found between changes in average ISD and the ex-post time series standard deviation of returns.

The above studies indicate that the model is still valuable in predicting ex-ante volatilities. Nevertheless, certain problems were encountered. Previously, the closing stock and option prices were used. This caused the nonsynchronous transactions problem. Beckers [1981] extended the previous studies by using a dividend-adjusted model to

derive the ISD. The closing price of an at-the-money option was used in comparison to weighted schemes of all options in the same class. He found the ISD derived from at-the-money options to be better predictors of the actual time-series standard deviation over the life of the option than a weighted ISD. Possible data problems were noted due to the existence of a bid-ask spread as well as the nonsynchronization of stock and option prices and the volatility of ISD over time. As a result, the simultaneous transaction data and the inter-temporal average of ISDs were also employed. The results confirm that serious bias may occur from using closing prices, which may be reduced by taking an inter-temporal average.

Brenner and Galai [1984] examined some properties of ISDs based on transactions data. The last transaction of the day appears to significantly deviate from the daily average ISDs. Longer maturity options show higher average ISDs than short maturities. Finally, they reject the hypothesis that stocks and options markets are efficient and synchronous. Consistent results were found by Rubinstein [1981], who used the simulation of ISDs to test a number of alternative option pricing models. Also, out-of-the-money options with shorter maturities seem to yield higher ISDs.

The application of ISDs in the investigation of information content of accounting data has been introduced by Patell and Wolfson [1979, 1981]. Patell and Wolfson [1979] examined the behavior of call option prices on dates leading to and including the annual earnings announcement date. The stock price variability imputed from the Black-Scholes model was based on closing stock and call option prices.

Earnings announcements were found to induce increases in stock return variance. The results, being consistent with the information content hypothesis, imply that future stock price increases may be anticipated by the market and may be reflected in the option prices. In their later study, Patell and Wolfson [1981] studied the information content of quarterly earnings announcements. The synchronous reporting of stock and option prices was employed to compute weighted average ISDs. The sample included only non-12/31 fiscal year firms in order to avoid the problem of temporal clustering of announcements. The ex-post as well as the ex-ante analysis of stock price variability were tested around the disclosure dates. The results indicated information content of quarterly earnings disclosures. In addition, the larger realized stock price changes appeared to be preceded by larger increases in implied average standard deviations.

Several studies on ISDs show high correlation between the ISDs and the ex-post estimates of future standard deviation over the expiration time of the options. In the context of incremental information content of ISDs over the historical standard deviations, Ajinkya and Gift [1985] examined the information contained in financial analysts' forecasts using the ISDs as a benchmark for future standard deviations. The ISDs were found to reflect the contemporaneous information content of dispersion of analysts' forecasts incrementally beyond those contained in the historical time-series of return standard deviations.

In summary, if the OPM model's assumptions are valid, and the investors' expectations of return standard deivation is fully reflected

in the option prices, the ISDs derived from the B-S model can improve the predictive ability of future standard deviation of returns.

Problems Encountered in Estimating ISDs

Estimation of ISDs requires the use of the B-S model to equate the model price with the actual price by employing a numerical search procedure. The predictive ability of the estimated ISD may be subject to some problems related to the data, the methodology, and the assumptions of the model. These issues are discussed below.

1. The lack of market synchronization was observed by Bookstaber [1981]. Research on ISDs before 1981 tended to employ closing stock and option prices that are subject to nonsimultaneity of transactions. The ISD imputed from the closing stock and option prices will then be biased.

2. The instability of ISD estimates across various exercise prices was noted by MacBeth and Merville [1980] and Beckers [1981]. Tests of the B-S model have also found that the model tends to misspecify the call price when deep-in-the-money or deep-out-of-the-money options are used and that the model works best for at-the-money options. The call options seem to be overpriced with deep-in-the-money options and underpriced with deep-out-of-the-money options. Beckers suggested the use of the ISD for at-the-money options which is consistent with tests of the B-S model. Moreover, the justifications are that all the available information should be reflected in the at-the-money option and that other option prices have too much noise to be of relevance.

3. Serious bias may result in estimating ISDs due to the use of closing price and average bid-ask spread. Beckers noted that closing prices are subject to market imperfections (e.g., artificial price setting by market makers) around the market closing time. The use of bid-ask averages for call prices can also bias the estimates when the real call price is close to either the bid or ask prices.

4. The nonstationarity of ISDs over time suggests that the ex-ante volatility as measured by the option price fluctuates widely from day to day and, hence, implies that the market overreacts to new information. Consequently, Beckers suggested the use of inter-temporal arithmetic average of ISD estimates. An average ISD measure is expected to be more predictive (i.e.,less bias) than a single day ISD estimate.

Measurement of ISD

The ISD can be derived using the B-S model by a numerical search procedure that equates the model price within a very small interval (such as 0.001) of the actual call price. The ISD then can be shown as the function of six variables.

$$ISD = f(C, S, X, t, r, d)$$

Since ISD fluctuates from day to day, a five-day average of ISD will be estimated using the same method as in Beckers' study. For each firm j, the average ISD (AISD) is calculated for each period as follows.

$$AISD_{jk} = \frac{1}{n} \sum_{i=1}^{n} ISD_{ijk}$$

where $AISD_{jk}$ = average implied standard deviation for stock j in period k,

ISD_{ijk} = implied standard deviation for stock j in day i of period k,

i = the estimation day for ISD, i=1,...,n.

Information and prices of the options to be included in the calculation of ISD need to satisfy the following criteria.

1. The observed option price and concurrent stock price for a sample firm must take place one hour before the market closes. This is to avoid some known market imperfections as mentioned earlier. The option price selected was either the first transaction of the day or the average bid-ask quote if there is no trading during the observation period.

2. The exercise price for the option of the sample firm must be close (within the range of $\pm$ \$ 5) to the underlying stock price. That is, the option selected has to be either an at-the-money (stock price equals exercise price) option or at lease a close-to-the-money option.

3. The selected option should have a medium term of maturity since ISD estimates have higher fluctuation for too short as well as too long option terms. On average, the medium term of options is between three to six months.

Measurement of Ex-post Risk

The ex-post estimate of stock return risk is usually measured by the standard deviation of a historical time series of a large number of returns. Cox and Rubinstein [1985, p.258] suggested the use of daily data in forecasting volatility for a period of less than one year. The

use of recent past data with closely spaced observations (e.g., daily returns) has two advantages: (1) it allows for a larger sample size without bringing in less relevant data from the distant past; and (2) it makes the estimates of volatility less sensitive to estimates of the mean. Consequently, in this study daily returns for trading in six consecutive months are used to estimate HSD.

The standard deviation of daily returns can be computed from the standard statistical measure as follows:

$$HSD_j = \sqrt{\frac{1}{T-1} \sum_{i=1}^{T} (R_{ij} - \overline{R}_j)^2}$$

where R_{ij} is the daily return for day i of stock j,

$\overline{R}_j$ is the expected return of stock j, and

T is the total number of days used in the HSD estimation.

The estimation period for both ISD and HSD excludes the period between merger announcements and completion since it is generally a period of uncertainty and instability in part due to the merger event. The valuation dates for the ISD and HSD estimates are set at six months before first public merger announcement and six months after merger consummation. The rationale for this is to use a period in which merger did not form expectation and allow sufficient time for belief revisions after merger. The profile of estimation periods is shown in figure 4.1.

Accounting Risk Measures

The role of accounting data has been examined in explaining and improving the prediction of the risk-return relationship of stocks. Ball and Brown [1968] found an association between unexpected earnings

changes and residual stock returns and showed that most of the stock price reactions occurred in anticipation of earnings announcements. Beaver [1968] reported a significantly larger variance of stock returns during the announcement period than in the nonannouncement period, implying that accounting earnings data convey new information to the market. The use of accounting data in improving the prediction of systematic risk is reported in Beaver, Kettler, and Scholes (BKS) [1970] and Hill and Stone (HS) [1980]. Both BKS and HS reported significant correlations between accounting risk measures and beta estimated from market data. Financial leverage and the covariation of a firm's earnings with the aggregate portfolio's earnings (accounting beta) contributed the highest correlations. This finding implies that the information provided by accounting measures is relevant to investors in assessing the riskiness of securities. More evidence is found in Eskew [1979], Elgers [1980], and Chen [1985].

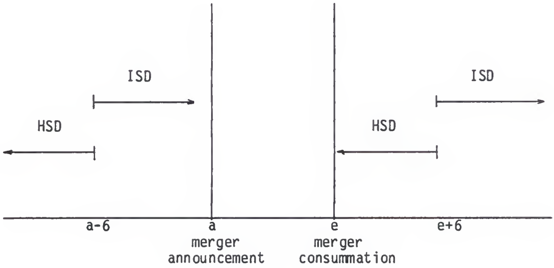

Figure 4.1. Estimation period of ex-ante and ex-post risk measures.

Hamada [1972] and Bowman [1979] elaborated on the conceptual relationship between accounting-based and market-based risk measures. Fundamental determinants of market risk consist of financial leverage, accounting beta, and earnings volatility. Bowman also reported that financial leverage based on accounting and market values yielded no different association with market-based beta.

This section discusses the accounting risk measures in three contexts: financial risk, operating risk, and the covariation of a firm's earnings with the market portfolio's earnings.

Financial Risk Proxies

As mentioned before, financial risk is the additional risk borne by common stockholders as a result of financial leverage. Accounting data provide book value measures of the firm's characteristics regarding leverage, liquidity, and the ability of a firm to pay back the principal and interest to debtholders as well as residual claims to shareholders. Financial leverage is found to be a fundamental determinant of the firm's riskiness (Hamada [1972] and Bowman [1979]). It will be employed in this study in addition to alternative measures of a current ratio and a payout ratio.

1. Financial leverage ratio. This ratio connotes the extent to which debt is a source of capital as well as an indicator of the probability that a firm meet obligations of debtholders in the long run. The approach to the measurement of the debt-equity ratio is total debt

to shareholders' equity.[1] This approach is consistent with the shareholders' view that all debtholders constitute a third party with claims on the firm's assets. In financial theory, debt should be measured by market value, which is the economic or replacement value of debt. However, the replacement value of debt is not as easily measurable. Bowman [1979] examined both market and book values and found no significant difference in an association with systematic risk.[2] Consequently, the accounting book value measures of both debt and equity will be used as risk measures. The ratio is calculated from the year-end reported figures before and after merger. It is expected that higher leverage induces higher equity risk.

2. Liquidity ratio. An alternative proxy for financial risk is the liquidity ratio referring to short-term obligations. Current ratio is commonly used in the ratio analysis, particularly in the empirical research on prediction of bankruptcy[3]. The current ratio, which is the ratio of current assets over current liabilities, tells how much the current liabilities are relatively covered by the firm's liquid assets. The larger is the net liquid-asset flow from operations (i.e., cash

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[1]Debt is defined as total current and long-term liabilities, and equity is defined as total common and preferred stockholders' equity.

[2]Bowman's results were challenged by Mulford [1985]. Contrary to Bowman's, Mulford's results showed superior performance for a market-based debt to equity ratio in an association with market beta than did their book value measures. The use of book value measures of the debt to equity ratio, although engaging less cost, might bias the results, particularly when high interest rates cause sizable differences between book and market values of debt.

[3]See Beaver [1966], Altman [1968], and Deakin [1972], for example. A review of studies on prediction of corporate failure can be found in Zavgren [1983].

flow), the smaller will be the probability of failure (Beaver [1966], p.80). If cash is used in a merger transaction, the financial risk will be affected. The less liquidity, the more risk of the combined firm after merger.

3. Payout ratio. The payout ratio proxies the dividend policy of the firm. This is measured by the ratio of cash dividends over earnings available for common stockholders. Beaver, Kettler, and Scholes [1970, p.660] viewed the payout ratio as a surrogate for management's perception of the uncertainty associated with the firm's earnings. If firms follow a dividend stabilization policy, then firms with greater volatility in earnings will pay out a lower percentage of expected earnings. To calculate the ratio, year-end accounting numbers of the years before and after merger are employed.

In summary, higher leverage, lower liquidity, and lower dividend payout contribute to the higher financial risk of a firm by increasing the uncertainty of debtholders regarding the firm's ability to pay back debts as they fall due.

Operating Risk Proxies

Operating risk refers to the risk in the process of revenue generation. Fundamental factors contributing to an increase in operating risk are earnings variability and the extent to which costs are fixed (operating leverage). Merger can change the volatility of operating earnings and operating leverage due to changes in the pattern of revenue production and in the size of the merged firms. Three accounting measures are used in this study as proxies for operating

risk: (1) coefficient of variation of earnings before interest and taxes [CV(EBIT)], (2) operating leverage, and (3) asset size.

1. CV(EBIT). The volatility of operating earnings is a fundamental determinant of equity risk as illustrated in chapter III. It reflects the uncertainty of firm's earnings due to fluctuation in demand, sales, production, and input costs. Earnings before interest and taxes are used as they reflect the operating decisions of management independently of financing decisions. The measure is derived from the standard deviation of EBIT using ten-year data scaled by its mean so that size differences among firms can be scaled.

2. Operating leverage. As discussed earlier, this ratio is suggested by Lev [1974] as a determinant of the firm's riskiness. Lev used the ratio of variable costs over total costs as a measure of operating leverage. For a high operating leverage (higher fixed costs and lower variable costs), the earnings volatility will increase with demand fluctuations, which, in turn, increases the firm's riskiness. A basic measure of operating leverage is the percentage change in operating profits over the percentage change in output levels. An equivalent formula is the ratio of operating income (or contribution) over earnings before interest and taxes (Van Horne [1980], p.774). This latter measure is employed here, and illustrated as follows:

$$\text{Operating Leverage} = \frac{Q\ (S_p - V_c)}{Q\ (S_p - V_c) - F}$$

$$\text{or} \qquad = \frac{\text{Operating income (OI)}}{\text{Earnings before interest and taxes (EBIT)}}$$

where Q is output, S_p is selling price, V_c is unit variable cost, and F is total fixed costs.

The higher are fixed costs, the higher will be the operating leverage, operating risk, and total equity risk of the firm.

3. Asset size. The size of firm is believed to be associated with the firm's riskiness. Horrigan [1966] showed that the single most important financial variable in predicting the bond rating of a firm was total assets. In the prediction of bankruptcy, Ohlson [1980] found the size variable (log of total assets/GNP price-level index) to be significant in bankruptcy prediction models. Large firms were found to be less risky than small firms. Size could also indicate the monopoly power of a firm. Subrahmanyam and Thomadakis [1980] developed a model of the firm under uncertainty and indicated that monopoly power was related to the systematic risk, which was also a part of total equity risk.

A competing theory relating to mergers as growth maximization (Reid [1968], Newbould [1970], and Firth [1980]) asserts that, beyond achieving a certain satisfactory level of profits, managers attempt to maximize their own self-interests that can be aided by growth in size. Larger firms allow management to increase their power and skills, to reduce the risk of losing their jobs if their firm is taken over,[4] and to increase their compensation levels. Mergers result in higher economies of scale and in larger market shares, both of which can generate higher monopoly power, as is the case with horizontal mergers.

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[4]Newbould [1970] showed that the percentage of small firms being taken over was greater than for large firms.

In addition, changes in operating efficiency due to combined management skills from both merging firms' management may determine the change in operating risk. Consequently, the larger is the firm size, the less will be the operating risk and thus total equity risk.

Correlation of Earnings

Correlation of earnings is a measure of the portion of the firm's risk tied to the market movements. Beaver, Kettler, and Scholes [1970] reported an association between accounting beta, which was a coefficient of regressing firms' earnings on the aggregate market's earnings, with the market beta. The correlation coefficient of individual firm's earnings and an aggregate market portfolio's earnings is used in this study. This measure, being a part of accounting beta as mentioned earlier, was also employed in Westerfield [1970] and Melicher and Rush [1973]. The correlation between security and market portfolio earnings could be interpreted as a measure of the extent to which the firm has efficiently diversified its asset portfolio [Westerfield, 1970]. As the correlation approaches one, systematic risk approaches total risk and, consequently, diversifiable risk approaches zero. The earnings variable chosen is primary earnings per share and the market earnings is the aggregate earnings per share of Standard & Poor 500 firms.[5] The estimation uses data for a ten-year period up to the estimation date.

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[5]The aggregate index of S&P Industry 400 firms was also employed, and yielded a consistent result.

Hypotheses and Research Design

Merger Impact Hypothesis

The primary research question in this study is whether the change in equity risk by merger is better captured by ISD as compared to HSD. The change in return volatility for each firm is measured by the difference between the standard deviation of returns before and after merger. The measures include both average implied standard deviation (AISD) and historical time-series standard deviation (HSD).

The diversification effect of merger predicts the risk reduction after merger, while the coinsurance effect asserts that shareholders increase leverage of the merged firm resulting in incremental risk. Since merger induces changes in both ways depending on the nature of merger, the average change effects may become neutral. The tests of absolute changes in risk is included to capture the difference in risk changes between the merger and control samples. The null and alternative hypotheses are stated as follows:

H_{01}: $|\Delta\sigma\ (R_i \mid \text{merger})| = |\Delta\sigma\ (R_i \mid \text{nonmerger})|$

H_{a1}: $|\Delta\sigma\ (R_i \mid \text{merger})| \neq |\Delta\sigma\ (R_i \mid \text{nonmerger})|$

where $\Delta\sigma \in (\Delta AISD, \Delta HSD)$

$$\Delta\sigma = \sigma_{post} - \sigma_{pre}$$

Ex-ante and Ex-post Risk Estimates

One way to evaluate the consistency and substitutability of ex-ante and ex-post estimates of return volatility is to test cross-sectional correlations between AISD and HSD in premerger and postmerger periods.

It is expected that the correlations between the AISD and the HSD are significant and positive (close to one), and stable from the periods before and after merger. Given that financial, operating, and/or market risk increase or decrease after merger, investors' expectations of the riskiness of a merger firm will be revised so as to reflect in the ex-ante and the ex-post risk estimates in a consistent manner. A higher correlation implies a higher strength of bivariate relationship between AISD and HSD. Consequently, this implies how well HSD may be used as an alternative proxy for ex-ante risk when ISD is not directly observable.

The Consistency of AISD and HSD. The null hypothesis tested for the consistency of AISD and HSD is whether these two are independent, while the alternative hypothesis indicates whether they are positively correlated. To test whether the relationship between AISD and HSD is stable, the Fisher Z transformation is used to investigate the difference of correlations in the periods before and after merger.

The second hypothesis for testing the consistency of AISD and HSD estimates is the following:

$$H_{o2}: \text{CORR (AISD, HSD)}_{pre} = 0$$
$$\text{CORR (AISD, HSD)}_{post} = 0$$
$$H_{a2}: \text{CORR (AISD, HSD)}_{pre} > 0$$
$$\text{CORR (AISD, HSD)}_{post} > 0.$$

The supplementary hypothesis is also tested to examine the stability of the relationship between AISD and HSD, which is stated as follows:

H_{o2}': CORR (AISD, HSD)$_{pre}$ = CORR (AISD, HSD)$_{post}$

H_{a2}': CORR (AISD, HSD)$_{pre}$ $\neq$ CORR (AISD, HSD)$_{post}$

The correlations are estimated for both merger and control samples.

The Substitutability of AISD and HSD. To test whether HSD can be used as a proxy for the future return volatility estimated by AISD, a regression of AISD as a function of HSD is estimated. The hypothesis is that the regression coefficient approaches one if the HSD is a good proxy for the AISD. If this hypothesis is rejected, then extraneous factors other than HSD may be impounded in the estimation of AISD. Given the model

$$AISD_j = \alpha_0 + \alpha_1 HSD_j + \varepsilon_j \qquad (4.1),$$

where α_0 and α_1 are regression coefficients,

j is a subscript for firm j, and

ε_j is the error term.

The hypothesis can then be expressed as follows:

H_{o2}'' : $\alpha_0 = 0$

$\alpha_1 = 1$

H_{a2}'' : $\alpha_0 \neq 0$

$\alpha_1 < 1.$

Predictive Ability of Accounting Risk Measures

In cases when the firm has no options traded and the implied standard deviation cannot be obtained, the question arises as to whether there are alternative sources of information to predict the future return volatility. In practice, the historical time-series standard deviation has been employed as a naive model in the prediction of a

firm's riskiness. As an alternative, the extent to which accounting measures of risk provide useful information for predicting changes in equity risk can be examined. The design is to develop expectation models of market-based risk using the accounting risk measures of financial risk, operating risk, and market risk.

The regressions are as follows:

$$AISD_j = a_0 + a_1DE_j + a_2CR_j + a_3PO_j + a_4CV_j + a_5OL_j + a_6TA_j + a_7MR_j + u_j \quad (4.2)$$

$$HSD_j = b_0 + b_1DE_j + b_2CR_j + b_3PO_j + b_4CV_j + b_5OL_j + b_6TA_j + b_7MR_j + v_j \quad (4.3)$$

where

a_i, b_i, $i=0,\ldots,7$, are regression coefficients,

j is a subscript for merger firm j,

u_j and v_j are error terms with expectation zero.

The description of variables is provided in table 4.1 below.

It is expected that higher financial leverage, lower liquidity, lower dividend payout, higher earnings variability, higher operating leverage, smaller asset size, and higher market correlation of earnings contribute to higher equity risk of a firm.

Consequently, the null and alternative hypotheses are written as follows:

H_{o3}: a_i, $b_i = 0$, where $i = 0,\ldots,7$

H_{a3}: a_1, $b_1 > 0$

a_2, $b_2 < 0$

a_3, $b_3 < 0$

$a_4, b_4 > 0$

$a_5, b_5 > 0$

$a_6, b_6 < 0$

$a_7, b_7 > 0.$

Merger impact evaluation. The difference in risk characteristics between merger and nonmerger firms can be evaluated by adding to the above models a dummy variable representing group and the interaction terms of the other variables with group.

Supplementary tests also include the test of a function's stability and incremental explanatory power of accounting risk measures over the historical time series standard deviation of returns.

Sample and Data

The study is based upon an analysis of merger firms during the period 1982-1984 whose names are listed on the Chicago Board of Option Exchanges (CBOE) market. Out of 144 firms, 52 merger firms were identified from Mergers & Acquisitions. Of the remaining 92 nonmerger firms, 52 firms were selected to be a control sample contingent on the availability of accounting data on Compustat tape. The criteria for inclusion into the experimental firms are as follows:

1. The merger must have been completed. No partial acquisitions was allowed.

2. There were no other significant mergers or divestitures announced within six months of the merger announcement or consummation date.

3. The sample firms must have data available on the Compustat Tape.

The merger announcement dates were identified from the Wall Street Journal Index. The merger consummation dates were obtained from Mergers & Acquisitions. Firms in the control sample were pair-matched with the test sample based on size.

The data for the option model variables were obtained from the Berkeley options data base tape for CBOE firms for the period 1/1/1982 to 12/31/1985. The test periods spanned six months before merger announcements and six months after merger consummations. Riskfree interest rates were treasury bill yields with maturity dates closest to the expiration of related options. T-bill yields were obtained from the Federal Reserve Bulletin for the Friday prior to the date of the ISD estimation. This choice is based on the assumption that investors use the most recent information available to them in setting the price of a security. The dividend yield information were obtained from the Wall Street Journal Index for the year preceding dates of interest.

Daily returns of stocks were obtained from the CRSP data base tape. Finally, the information related to accounting numbers was retrieved from the Compustat tape. Supplementary data were obtained from Moody's Industrial Manual, S&P's Statistical Services, and from the annual-report microfiche of the University of Florida library.

TABLE 4.1

Description of Accounting Risk Measures

Variable	Description	
	Financial risk	
DE	Financial leverage	$\frac{\text{Total book value debt}}{\text{Total book value equity}}$
CR	Liquidity ratio	$\frac{\text{Current assets}}{\text{Current liabilities}}$
PO	Payout ratio	$\frac{\text{Cash dividends}}{\text{Net income}}$
	Operating risk	
CV	Earnings volatility	$CV(EBIT) = \frac{\sigma(EBIT)}{E(EBIT)}$
OL	Operating leverage	$\frac{\text{Operating income}}{\text{Earnings before interest and taxes}}$
TA	Total asset size	Total assets
	Market risk	
MR	Correlation of earnings	$\rho(EPS_j, EPS_m)$

Note:

CV(EBIT) is the coefficient of variation of earnings before interest and taxes.
EPS_j is the primary earnings per share of firm j.
EPS_m is the primary earnings per share of S&P 500 firms.

CHAPTER V
EMPIRICAL RESULTS AND DISCUSSION

Sample Characteristics

The univariate statistics of market and accounting measures of risk are presented in table 5.1. A total of 52 merger and 52 control firms during the years 1982 to 1984 were identified as outlined below. Of these 52 mergers, 32 mergers were of the nonconglomerate type while the remaining 20 mergers were conglomerates. The classification was based on the type of industry of the merging firms as appeared in Mergers & Acquisitions and also checked against the Moody's Industrial Manual. Nonconglomerates are mergers between firms producing or engaging in the same or closely related products. Conglomerates are mergers between firms that are functionally unrelated. The list of merger and target firms is provided in appendix A. In addition, of the observed 52 merger firms, 45 mergers were engaged in cash, notes, and stock transactions, while the remaining 7 firms employed stock-for-stock transactions. It was also noted that the purchase accounting method was used in those 45 firms engaging in cash-and-stock-exchange mergers, while the pooling accounting method was used in 7 stock-swap mergers. One outlier of each merger and control firms in each period was removed due to a uniquely

high level of debt-equity ratio and high earnings variability.[1] Table 5.1 provides the mean and standard deviation for the sample of 51 merger and 51 control firms for each period, before and after merger. The t-value statistics for mean differences between risk variables of merger and control firms are also given. There are no significant differences in risk characteristics between the merger and control firms for both period. However, it is noteworthy that the merger group had a higher debt-equity ratio, and lower variation in earnings before interest and taxes than those of the control group. In table 5.2, the t-statistics for the mean differences in variables between the periods premerger and postmerger are provided. The average implied standard deviation (AISD) in table 5.2 decreased significantly for both merger and control firms. However, the ex-post measure of risk (HSD) did not change significantly after merger for either group. As for the accounting risk measures, the mean and standard deviation of the debt-equity ratio in table 5.1 are higher for the merger group than those for the control group during both periods. In contrast, the coefficient of variation in EBIT which is measured by the standard deviation of EBIT divided by its mean shows smaller averages and standard deviations for the merger firms than for the control firms. Finally, operating leverage and payout ratio, though having insignificantly different means, have variances which are

[1]The outlier observations were conclusively identified based on an analysis of Cook's distance statistic which measures the influence of that observation on the set of estimated regression coefficients in later analysis. It measured the distance between the values of coefficients with all observations present and those values with that observation removed.

TABLE 5.1

Summary Statistics for Risk Variables

Variable	Mean: Merger (n=51)	Mean: Control (n=51)	Standard Deviation: Merger	Standard Deviation: Control	t-value[a]	F-value[b]
			Premerger			
AISD	0.3536	0.3530	0.0980	0.0943	-0.031	1.08
HSD	0.3260	0.3353	0.0802	0.1189	0.464	2.20
DE	1.6747	1.1988	3.2534	0.7799	-1.016	17.40***
CR	2.0368	2.0372	1.0522	0.9379	0.002	1.26
PAYOUT	0.4030	0.4848	0.4541	0.7118	0.692	2.46***
CV(EBIT)	47.4640	53.4539	20.6479	33.8801	1.078	2.69***
OL	0.1081	1.2477	6.0342	0.5031	1.344	143.86***
TA	4038.2295	4464.9128	3223.4214	4628.6062	0.540	2.06**
MR	0.4122	0.3468	0.4578	0.5129	-0.679	1.26
			Postmerger			
AISD	0.3210	0.3192	0.0768	0.0739	-0.123	1.08
HSD	0.3092	0.3214	0.0805	0.0899	0.717	1.25
DE	1.8937	1.1928	3.7016	0.8199	-1.320	20.38***
CR	1.9424	1.9517	0.8694	0.8762	0.054	1.02
PAYOUT	0.3160	0.3826	0.7611	0.3343	0.572	5.18***
CV(EBIT)	45.8781	53.2020	19.6883	35.7206	1.282	3.29***
OL	1.7520	1.2171	2.7603	0.4690	-1.364	34.64***
TA	4880.2453	4665.9057	4088.0213	4567.3734	-0.250	1.25
MR	0.3112	0.2569	0.4687	0.5415	-0.542	1.33

Note: a - t-value is the t-statistic for mean differences between merger and control groups.
b - F-value is the F-statistic for testing the hypothesis that the variances between two groups are equal.
* - significant at the 0.10 level of significance.
** - significant at the 0.05 level of significance.
*** - significant at the 0.01 level of significance.

TABLE 5.2

Test of Differences in Level of Risk Variables Within Sample

Variable	Merger	Control
	t-value (post-pre)[a]	
AISD	-1.87*	-2.02**
HSD	-1.05	-0.67
DE	0.32	-0.04
CR	-0.49	-0.48
PAYOUT	-0.70	-0.93
CV(EBIT)	-0.40	-0.04
OL	1.77*	-0.32
TA	1.16	0.22
MR	-1.10	-0.86

Note: a - Negative t-value means the postmerger risk measure is less than that premerger.
* - significant at the 0.10 level of significance.
** - significant at the 0.05 level of significance.

significantly different as observed from the F-statistics (the last column of table 5.1).

The implications of these statistics for the merger and control groups are discussed in the following sections concerning the empirical tests of the hypotheses under study.

The Test of the Impact of Merger on Equity Risk

If the merger has certain impact, the distribution of risk after merger will be different from that before merger and the null hypothesis of no merger impact would be rejected. Table 5.2 provides the t-statistics for the shift in risk within each merger and control sample. Table 5.3 presents the same results using nonparametric tests (Fisher sign test and Wilcoxon signed rank test).[2] The number of observations with decreases in risk, the Fisher sign test statistic, and the Wilcoxon signed-rank test statistics for each sample are also presented in table 5.3. Both parametric and nonpara- metric tests show significant decreases in ex-ante risk measure for both the merger and control groups.

As for the accounting risk characteristics, marginally significant increase in debt-equity ratio can be detected for the merger sample, but not for the control sample. Furthermore, the sign test and signed rank test show significant decrease in variation of EBIT, significant

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[2]The Fisher sign test and the Wilcoxon signed rank test are both distribution-free nonparametric test. They are different in that the Fisher sign test does not assume symmetric distribution like the Wilcoxon signed rank test. The sign test needs to know only the signs of the differences, whereas the signed rank test must know both the signs and the ranks of absolute value of differences.

TABLE 5.3

The Results of the Nonparametric tests of Risk Changes Within Samples

Variable	Merger # Decreases	Merger Fisher Sign	Merger Wilcoxon Signed rank	Control # Decreases	Control Fisher Sign	Control Wilcoxon Signed rank
			Statistic (p-value)[a]			
ΔAISD	34	-2.38** (.0174)	-2.33** (.0198)	31	-1.54 (.1236)	-2.33** (.0198)
ΔHSD	30	-1.26 (.2076)	-1.33 (.1836)	25	0.14 (.8886)	-0.16 (.8728)
ΔDE	21	1.26 (.2076)	1.72* (.0854)	26	-0.14 (.8886)	-0.71 (.4778)
ΔCR	30	-1.26 (.2076)	-1.42 (.1558)	30	-1.26 (.2076)	-1.36 (.1738)
ΔPAYOUT	28	-0.70 (.4840)	-0.29 (.7718)	29	-0.98 (.3270)	-0.10 (.9204)
ΔCV(EBIT)	33	-2.10** (.0358)	-2.17** (.0300)	40	-4.06*** (.0001)	-3.58*** (.0001)
ΔOL	29	-0.98 (.3270)	-0.32 (.7490)	24	0.42 (.6744)	0.43 (.6672)
ΔTA	11	4.06*** (.0001)	4.86*** (.0001)	11	4.06*** (.0001)	3.61*** (.0001)
ΔMR	42	-4.62*** (.0001)	-5.04*** (.0001)	35	-2.66*** (.0078)	-2.97*** (.0030)

Note: a - Tests are two-tailed tests.
* - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.

increase in asset size, and significant decrease in covariation of earnings for both samples. The t-test results in table 5.2 are consistent with those in table 5.3 in terms of direction of risk shift (except for operating leverage), but not in terms of significance.

The second step is to examine the difference in risk changes between samples. The test hypothesis posits that the changes in equity risk are higher for merger firms than that of the control firms. The three measures used for risk changes are the average change, percentage changes, and absolute changes. The average and percentage changes take account of the directions of changes whereas the absolute change only implies the magnitude of changes. The absolute changes in risk measures for merger firms are expected to be larger than for control firms.

Table 5.4 presents the results of the t-test of the difference in risk change between merger and control firms. These results do not support the hypothesis. There are no significant differences between risk changes for the merger and control groups for both the average change and the percentage change. For the magnitude of changes in the ex-post risk measure (HSD), significant differences opposite of the hypothesized direction are obtained. That is, control group seems to have larger changes in HSD.

Two significant changes in accounting risk proxies are apparent. The merger firms appear to have an increase in financial leverage (debt to equity) while the control firms under study have a decrease, on average. This is consistent with the merger coinsurance hypothesis that predicts the shareholders take protective action by increasing leverage of the merged firm. Another significant change is the increase in asset

TABLE 5.4

The Results of the T-test of Differences in Risk Changes Between Merger and Control Firms

Variable	Average Change[a]			Percentage Change[b]			Absolute Change[c]		
	Merger	Control	t	Merger	Control	t	Merger	Control	t
				Statistic[d]					
Δ AISD	-0.028 (0.080)	-0.033 (0.085)	-0.28	-4.474 (24.672)	-6.400 (21.524)	-0.42	0.065 (0.053)	0.069 (0.059)	0.37
Δ HSD	-0.012 (0.074)	-0.013 (0.127)	-0.04	-1.969 (22.713)	2.309 (33.403)	0.76	0.060 (0.045)	0.089 (0.085)	2.03***
Δ DE	0.231 (0.637)	-0.028 (0.325)	-2.58***	17.262 (48.934)	0.203 (28.760)	-2.15**	0.336 (0.587)	0.182 (0.269)	-1.70
Δ CR	-0.104 (0.570)	-0.054 (0.562)	0.45	-2.044 (28.461)	-0.663 (23.442)	0.27	0.291 (0.499)	0.273 (0.493)	-0.18
Δ PAYOUT	-0.001 (1.088)	-0.102 (0.716)	-0.56	23.710 (406.678)	-14.889 (87.560)	-0.66	0.437 (0.994)	0.256 (0.676)	-1.07
Δ CV(EBIT)	-0.017 (0.158)	0.003 (0.381)	0.34	-0.037 (0.458)	0.015 (0.942)	0.36	0.113 (0.111)	0.194 (0.326)	1.68*
Δ OL	0.425 (2.154)	0.041 (1.247)	-1.10	45.578 (184.843)	103.536 (589.030)	0.67	0.628 (2.102)	0.428 (1.170)	-0.60
Δ TA	734.325 (1616.09)	147.858 (379.23)	-2.52***	18.322 (29.483)	6.379 (8.649)	-2.78***	788.645 (1589.769	289.135 (284.335)	-2.21**
Δ MR	-0.110 (0.147)	-0.087 (0.212)	0.63	4.990 (138.457)	32.981 (174.678)	0.90	0.123 (0.135)	0.158 (0.164)	1.18

Note: a - Average change = $Risk_{post} - Risk_{pre}$.
b - Percentage change = $[(Risk_{post} - Risk_{pre})/Risk_{pre}]*100$.
c - Absolute change = Absolute(Average change).
d - The number in parenthesis is the standard deviation.
* - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.

size for the merger firms, which is expected due to the nature of transaction.

Consistent results were also obtained using Wilcoxon rank sum test shown in table 5.5.

TABLE 5.5

Wilcoxon Rank Sum Test for Differences in risk Between Samples

Variable	Average Change		Absolute Change	
	Wilcoxon Rank-sum	P-value	Wilcoxon Rank-sum	P-value
ΔAISD	-0.03	.9786	0.20	.8409
ΔHSD	0.86	.3879	1.04	.2996
ΔDE	-1.81*	.0708	-0.73	.4677
ΔCR	0.14	.8909	0.43	.6708
ΔPAYOUT	0.19	.8513	0.12	.9120
ΔCV(EBIT)	-1.81*	.0708	1.53	.1254
ΔOL	0.58	.5604	-0.56	.5740
ΔTA	-1.51	.1304	-0.68	.4990
ΔMR	0.92	.3557	1.20	.2283

Note: * - Significant at the 0.10 level of significance.

An Evaluation of Ex-ante and Ex-post Risk Measures

The ex-ante risk measure based on the implied standard deviation from a call option price contains a value of investors' beliefs about the future stochastic behavior of the underlying stock over the remaining life of the option contract. Consequently, it can be used as a benchmark for future stock return variability. The second hypothesis in this study tests how well the ex-post estimation of return variability (HSD) can describe the ex-ante risk estimation as implied by average ISDs. To test the relationship between ex-ante risk and ex-post risk measures, the Pearson product-moment correlations were estimated for the following variables:

1. the average ISDs for five days estimated at six months before and six months after merger;

2. the standard deviation of daily returns calculated over the six month period up to the estimation dates of AISD; and

3. selected accounting risk measures proxying for financial risk, operating risk, and market risk (as defined in chapter III) computed from the year-end period immediately preceding estimation dates. It is presumed that investors in general use the most recent public information available.

Given previous results of no difference in changes in market risk due to merger, it is expected that AISDs will be highly correlated to HSDs in both periods for both sample firms. The results of pairwise correlations for both merger and control samples in each period are presented in tables 5.6 to 5.9.

TABLE 5.6

Premerger Pairwise Correlation Coefficients -- Merger Group
Pearson Correlations (P-value)

	Premerger							
	HSD	DE	CR	PAYOUT	CV(EBIT)	OL	TA	MR
AISD	0.852*** (0.0001)	0.311** (0.026)	0.057 (0.690)	-0.139 (0.332)	0.434*** (0.001)	-0.347** (0.013)	-0.254* (0.072)	-0.230 (0.104)
HSD		0.362*** (0.009)	0.001 (0.996)	-0.146 (0.306)	0.375*** (0.007)	-0.372*** (0.007)	-0.151 (0.290)	-0.234* (0.098)
DE			-0.282** (0.045)	-0.283** (0.045)	-0.098 (0.492)	-0.015 (0.916)	0.500*** (0.0002)	-0.244* (0.084)
CR				-0.027 (0.852)	0.126 (0.378)	0.075 (0.599)	-0.267* (0.058)	-0.145 (0.310)
PAYOUT					-0.437*** (0.001)	0.203 (0.152)	0.011 (0.940)	-0.115 (0.421)
CV(EBIT)						-0.399*** (0.004)	-0.276** (0.050)	-0.054 (0.706)
OL							0.183 (0.199)	0.147 (0.304)
TA								-0.269* (0.056)

Note: * - significant at the 0.10 level of significance.
** - significant at the 0.05 level of significance.
*** - significant at the 0.01 level of significance.

TABLE 5.7

Postmerger Pairwise Correlation Coefficients -- Merger Group
Pearson Correlations (P-value)

	Postmerger							
	HSD	DE	CR	PAYOUT	CV(EBIT)	OL	TA	MR
AISD	0.732*** (0.0001)	0.417*** (0.002)	0.077 (0.593)	0.073 (0.612)	0.399*** (0.004)	-0.155 (0.276)	-0.020 (0.888)	-0.080 (0.576)
HSD		0.418*** (0.002)	-0.067 (0.640)	-0.080 (0.579)	0.391*** (0.005)	0.201 (0.157)	-0.023 (0.875)	-0.146 (0.306)
DE			-0.337** (0.016)	-0.062 (0.667)	-0.0004 (0.998)	-0.071 (0.622)	0.573*** (0.0001)	-0.197 (0.167)
CR				-0.076 (0.596)	0.047 (0.742)	-0.215 (0.129)	-0.376*** (0.007)	-0.143 (0.318)
PAYOUT					-0.137 (0.339)	-0.297** (0.034)	0.116 (0.416)	0.193 (0.175)
CV(EBIT)						-0.038 (0.793)	-0.117 (0.413)	0.012 (0.934)
OL							-0.115 (0.420)	-0.084 (0.559)
TA								-0.214 (0.132)

Note: * - significant at the 0.10 level of significance.
** - significant at the 0.05 level of significance.
*** - significant at the 0.01 level of significance.

TABLE 5.8

Premerger Pairwise Correlation Coefficients -- Control Group
Pearson Correlations (P-value)

	Premerger							
	HSD	DE	CR	PAYOUT	CV(EBIT)	OL	TA	MR
AISD	0.754*** (0.0001)	-0.119 (0.407)	0.329** (0.018)	-0.118 (0.410)	0.474*** (0.0004)	0.075 (0.599)	-0.350*** (0.012)	0.019 (0.893)
HSD		0.087 (0.543)	0.297** (0.034)	-0.104 (0.469)	0.309** (0.028)	0.125 (0.383)	-0.238* (0.092)	0.053 (0.710)
DE			-0.423*** (0.002)	0.061 (0.666)	0.018 (0.902)	0.039 (0.786)	0.038 (0.792)	-0.332** (0.017)
CR				-0.265* (0.060)	0.047 (0.744)	-0.050 (0.729)	-0.163 (0.254)	0.161 (0.260)
PAYOUT					-0.136 (0.340)	-0.249* (0.078)	0.113 (0.430)	-0.173 (0.224)
CV(EBIT)						-0.213 (0.133)	-0.346** (0.013)	0.037 (0.794)
OL							0.011 (0.941)	0.004 (0.979)
TA								-0.272* (0.054)

Note: * - significant at the 0.10 level of significance.
** - significant at the 0.05 level of significance.
*** - significant at the 0.01 level of significance.

TABLE 5.9

Postmerger Pairwise Correlation Coefficients -- Control Group
Pearson Correlations (P-value)

	Postmerger							
	HSD	DE	CR	PAYOUT	CV(EBIT)	OL	TA	MR
AISD	0.670*** (0.0001)	0.034 (0.811)	-0.038 (0.789)	-0.424*** (0.002)	0.653*** (0.0001)	-0.001 (0.995)	-0.248* (0.080)	-0.078 (0.585)
HSD		0.167 (0.242)	-0.054 (0.705)	-0.361*** (0.009)	0.481*** (0.0004)	0.114 (0.428)	-0.194 (0.171)	-0.119 (0.406)
DE			-0.315** (0.024)	-0.189 (0.184)	0.116 (0.417)	0.110 (0.443)	0.030 (0.832)	-0.298** (0.034)
CR				-0.024 (0.866)	-0.233* (0.100)	0.040 (0.783)	-0.123 (0.392)	0.213 (0.133)
PAYOUT					-0.543*** (0.0001)	0.324** (0.020)	0.480*** (0.0004)	-0.202 (0.155)
CV(EBIT)						-0.160 (0.261)	-0.288** (0.040)	0.011 (0.939)
OL							0.054 (0.709)	-0.085 (0.551)
TA								-0.247* (0.081)

Note: * - significant at the 0.10 level of significance.
** - significant at the 0.05 level of significance.
*** - significant at the 0.01 level of significance.

Table 5.6 gives pairwise Pearson correlation coefficients for the merger sample during the premerger period. The next three tables give similar measures for merger firms during the postmerger period, control firms for the premerger period, and control firms for the postmerger period, respectively. The overall results show significantly high correlations between AISD and HSD consistently for both samples and in both periods suggesting that the measure of past return variability is a good estimate of future return variability.

As for the accounting measures of risk, the numbers in the first two rows of each correlation table show the pairwise correlations between each accounting measure and each market risk measure. The coefficient of variation in earnings before interest and taxes had the strongest relationship with both ex-ante and ex-post market risk measures consistently for both samples. The debt-equity ratio was associated with market risk measures for the merger sample in both periods before and after merger, but not for the control sample.

To test for the equality of correlation between AISD and HSD during the periods before and after merger, the Fisher Z transformation[3] was used for Pearson correlations.

---

[3] $Z_i = \left(\frac{1}{2}\right) [\ln(1+r_i) - \ln(1-r_i)]$

where r_i is sample i's correlation coefficient,
and $Z = \dfrac{Z_1 - Z_2}{\sqrt{\dfrac{1}{n_1-3} + \dfrac{1}{n_2-3}}}$ -- $N(0,1)$ under H_0: $CORR_1 = CORR_2$

The results in table 5.10 show that the strength of relationship between AISD and HSD was not significantly different for the two periods before and after merger.

TABLE 5.10

Test of Equality Between Correlations Premerger and Postmerger

Pearson Correlation	Pre	Post	Fisher Z	P-value[a]
Merger Firm				
AISD, HSD	.852	.732	1.61	.1074
Control Firm				
AISD, HSD	.754	.670	0.83	.4066

Note: a - The smallest level of significance for a two-tailed test.

The Test of the Substitutability of AISD and HSD

The regression results of the model of AISD as a function of HSD were shown in table 5.11. The hypothesis that the regression coefficient of HSD equals one could not be rejected for the merger sample in the premerger period. On the contrary, such coefficients were significantly different from one in the postmerger period for the merger sample, and in both periods for the control sample. The regressions of the combined merger and control samples using the group (1 for merger and 0 for control firms) as a dummy variable together with its

TABLE 5.11

Results of the Test of the Substitutability of AISD and HSD
Model: $AISD_j = \alpha_0 + \alpha_1 HSD_j + \varepsilon_j$
(n=51)

	Premerger		Postmerger	
	α_0	α_1	α_0	α_1
Merger				
Coefficients	0.014	1.040	0.105	0.699
T-value (H_0: $\alpha_0 = 0$, $\alpha_1 = 0$)	0.472	11.383***	3.536***	7.514***
F-value (H_0: $\alpha_1 = 1$)		0.196		10.514***
Probability > F		0.660		0.002
Adjusted R^2		0.720		0.526
Control				
Coefficients	0.153	0.598	0.142	0.550
T-value (H_0: $\alpha_0 = 0$, $\alpha_1 = 0$)	5.768***	8.034***	4.898***	6.316***
F-value (H_0: $\alpha_1 = 1$)		29.188***		26.628***
Probability > F		0.0001		0.0001
Adjusted R^2		0.560		0.438

Note: * - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.

TABLE 5.12

Test of the Substitutability of AISD and HSD Between Groups
Model: $AISD_j = \alpha_0 + \alpha_1 HSD_j + \alpha_2 GP_j + \alpha_3 GP{*}HSD_j + \varepsilon_j$

	Premerger	Postmerger
	Regression Coefficient (t-value)	
Constant	.1525 (6.281)***	.1423 (5.011)***
HSD	.5979 (8.748)***	.5503 (6.462)***
GP	-.1381 (-3.306)***	-.0373 (-.897)
GP*HSD	.4425 (3.621)***	.1482 (1.160)
Adjusted R^2	.639	.478
F-value (H_0: $\alpha_1 = 1$)	34.607***	27.871***
F-value (H_0: $\alpha_1+\alpha_3 = 1$)	.159	10.023***

Note: * - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.

interaction were also examined. The results, as presented in table 5.12, showed that the association between AISD and HSD was significantly different between merger and control firms in the premerger period, but not significantly different in the postmerger period. The results imply that HSD is effective in approximating the future equity risk of a firm before merger. When there is a merger intervention, however, the HSD may not be a good proxy of the future return volatility. Consequently, after merger, the AISD should be used to approximate the future risk.

The Predictive Ability of Accounting Risk Measures

The third objective is to test whether accounting risk measures are impounded in market expectation and realization of equity risk. The regression models (4.2 and 4.3) expressing market risk measures (AISD, HSD) as a function of accounting risk variables were estimated for the periods before and after merger for each sample. Seven accounting variables were selected as proxies for financial risk, operating risk, and market risk as shown earlier in chapter IV.

Table 5.13 provides the results of regression functions for the merger sample in both periods premerger and postmerger, and table 5.14 gives the results for the control group.

For the merger sample, three accounting risk measures are found to have significant coefficients in the expected direction for the market risk measures. These are the debt-equity ratio, the coefficient of variation in EBIT, and the asset size. The significant results were consistent for both periods. For the control sample, the most significant accounting risk measure for both periods was the

TABLE 5.13

Summary Statistics for Accounting Risk Model: Merger Sample (n=51)

Dependent	Expected Sign	Premerger AISD	Premerger HSD	Postmerger AISD	Postmerger HSD
Independent		Regression Coefficient (t-value)			
Constant	(+)	0.264 (4.55)***	0.254 (5.10)***	0.228 (5.27)***	0.216 (4.77)***
DE	(+)	0.019 (4.62)***	0.015 (4.21)***	0.014 (4.71)***	0.014 (4.53)***
CR	(-)	0.006 (0.52)	0.003 (0.35)	0.014 (1.17)	0.006 (0.49)
PO	(-)	0.051 (1.81)[a]	0.037 (1.50)	0.022 (1.76)[a]	0.016 (1.27)
CV(EBIT)	(+)	0.002 (3.11)***	0.001 (2.44)***	0.002 (3.37)***	0.002 (3.39)***
OL	(+)	-0.002 (-1.06)	-0.003 (-1.53)	-0.001 (-0.32)	0.008 (2.21)**
TA	(-)	-0.00001 (-3.41)***	-0.00001 (-2.44)***	-0.00001 (-2.29)**	-0.00001 (-2.20)**
MR	(+)	-0.026 (-0.99)	-0.017 (-0.76)	-0.008 (-0.40)	-0.016 (-0.76)
F-model		6.965***	5.391***	5.526***	5.553***
Adjusted R^2		0.455	0.381	0.388	0.389

Note: * - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.
a - Significant at the 0.10 level of significance for a two-tailed test, but contrary to the expected directional hypothesis.

TABLE 5.14

Summary Statistics for Accounting Risk Model:
Control Sample (n=51)

Dependent	Expected Sign	Premerger AISD	Premerger HSD	Postmerger AISD	Postmerger HSD
Independent		Regression Coefficient (t-value)			
Constant	(+)	0.191 (2.69)***	0.045 (0.47)	0.243 (5.28)***	0.230 (3.60)***
DE	(+)	-0.004 (-0.23)	0.040 (1.75)**	-0.010 (-0.85)	0.002 (0.13)
CR	(-)	0.032 (2.26)[a]	0.052 (2.74)[b]	0.008 (0.74)	0.006 (0.44)
PO	(-)	0.012 (0.66)	0.018 (0.76)	-0.041 (-1.16)	-0.067 (-1.34)
CV(EBIT)	(+)	0.001 (3.47)***	0.001 (2.24)**	0.001 (4.39)***	0.001 (2.52)***
OL	(+)	0.040 (1.67)**	0.055 (1.66)*	0.024 (1.27)	0.046 (1.75)**
TA	(-)	-0.000004 (-1.31)*	-0.000002 (-0.46)	-0.00000 (-0.14)	-0.00000 (-0.05)
MR	(+)	-0.017 (-0.69)	0.014 (0.43)	-0.023 (-1.36)	-0.027 (-1.17)
F-model		3.946***	2.416**	5.776***	3.000***
Adjusted R^2		0.292	0.165	0.401	0.219

Note: * - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.
a - Significant at the 0.05 level of significance for a two-tailed test, but contrary to the expected directional hypothesis.
b - Significant at the 0.01 level of significance for a two-tailed test, but contrary to the expected directional hypothesis.

coefficientof variation in EBIT. The current ratio was significant only in the premerger period. Operating leverage is weakly related to HSD in both periods, and to AISD in only the premerger period. However, only CV(EBIT) and asset size have the expected signs for the control group. The change in sign is observed for the payout variable of the control sample in the postmerger period.

Merger Impact Evaluation

To examine the merger impact on the accounting risk functions, a dummy variable indicating the type of firm (merger or control) is added to the models. A significant coefficient would mean that, conditional on other variables in the model, equity risk differs for both sample firms. In addition, the interaction effects between the dummy variable and each of the accounting risk variables were included. The slopes of the accounting risk variables for the two samples would be different for variables having significant interaction coefficients. The interaction model is provided below.

$$\begin{aligned} SD_j = a_0 &+ a_1DE_j + a_2CR_j + a_3PO_j + a_4CV_j + a_5OL_j + a_6TA_j + a_7MR_j \\ &+ a_8GP_j + a_9GP{*}DE_j + a_{10}GP{*}CR_j + a_{11}GP{*}PO_j + a_{12}GP{*}CV_j \\ &+ a_{13}GP{*}OL_j + a_{14}GP{*}TA_j + a_{15}GP{*}MR_j + w_j \qquad (5.1) \end{aligned}$$

where a_0, . . ., a_{15} are regression coefficients,

GP = 1 for merger group,

= 0 for control group, and

w_j is an error term for observation j.

SD_j is either $AISD_j$ or HSD_j.

Table 5.15 provides the results of estimating the above model of combined samples for each period. Model 5.1 yields the same result as the separate regression for the control group when GP=0.

The results in table 5.15 show that the merger and control firms differ for size and operating leverage as shown by the coefficient of interaction terms for GP*TA and GP*OL in explaining AISD during premerger. For the HSD model during premerger, the merger sample has a higher intercept than the control sample, and has a different slope for current ratio and operating leverage. After merger the functions of both group are not as distinguishable. Only the AISD model of the merger firms show a difference in effect of debt-equity ratio. The results are consistent with the previous estimation of the separate regressions.

In conclusion, the coefficient of variation of EBIT is a significant variable for both the expected and realized equity risk measures for all stocks in the sample during both periods. It should be noted from table 5.15 that the explanatory power of accounting variables is greater for AISD (R^2 about 0.38) than for HSD (R^2 ranging from 0.227 to 0.291).

The Stability of Accounting Risk Measures Function

The objective of testing whether the function is stable is to examine if the equity risk function using accounting risk measures during the premerger period can be employed to predict the equity risk after merger. The test is included because the premerger period data would be available for an investor to construct an equity risk function.

TABLE 5.15

Summary Statistics for Accounting Risk Model
With Group-Interaction Effects:
Combined Sample (n=102)

Dependent	Premerger AISD	Premerger HSD	Postmerger AISD	Postmerger HSD
Independent	Regression Coefficient (t-value)			
Constant	.191 (2.81)***	.045 (0.57)	.243 (5.15)***	.230 (3.99)**
DE	-.004 (-.24)	.040 (2.13)**	-.010 (-.82)	.002 (0.15)
CR	.032 (2.37)[a]	.052 (3.35)[b]	.008 (0.72)	.006 (0.49)
PO	.012 (0.69)	.018 (0.93)	-.041 (-1.13)	-.067 (-1.49)
CV	.001 (3.62)***	.001 (2.74)***	.001 (4.28)***	.001 (2.79)***
OL	.040 (1.74)*	.055 (2.03)**	.024 (1.23)	.046 (1.94)**
TA	-.000 (-1.37)	-.000 (-.56)	-.000 (-.13)	-.000 (-.05)
MR	-.017 (-.72)	.014 (0.53)	-.023 (-1.33)	-.027 (-1.30)
GP	.073 (0.80)	.212 (1.99)**	-.015 (-.23)	-.014 (-.18)
GP*DE	.023 (1.37)	-.025 (-1.29)	.024 (1.93)**	.012 (0.79)
GP*CR	-.026 (-1.47)	-.049 (-2.37)**	.006 (0.39)	-.000 (-.02)
GP*PO	.040 (1.16)	.019 (0.47)	.063 (1.64)*	.083 (1.76)*
GP*CV	.001 (0.90)	.000 (0.23)	.000 (0.45)	.001 (0.89)
GP*OL	-.042 (-1.82)*	-.057 (-2.12)**	-.025 (-1.27)	-.038 (-1.58)
GP*TA	-.000 (-2.05)**	-.000 (-1.18)	-.000 (-1.75)*	-.000 (-1.48)
GP*MR	-.009 (-.25)	-.032 (-.75)	.015 (0.57)	.011 (0.35)
F-model	4.962***	2.975***	5.270***	3.766***
Adjusted R^2	.371	.227	.388	.291

Note:
* - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.
a - Significant at the 0.05 level of significance, but contrary to the expected directional hypothesis.
b - Significant at the 0.01 level of significance, but contrary to the expected directional hypothesis.

Consequently, the combined regression before and after merger is employed. A dummy variable indicating the period (PR) was introduced. The modified model for equity risk is given as follows:

$$\begin{aligned} SD_j = a_0 &+ a_1DE_j + a_2CR_j + a_3PO_j + a_4CV_j + a_5OL_j + a_6TA_j + a_7MR_j \\ &+ a_8PR_j + a_9PR{*}DE_j + a_{10}PR{*}CR_j + a_{11}PR{*}PO_j + a_{12}PR{*}CV_j \\ &+ a_{13}PR{*}OL_j + a_{14}PR{*}TA_j + a_{15}PR{*}MR_j + z_j \qquad (5.2) \end{aligned}$$

where a_0, . . ., a_{15} are regression coefficients,

PR = 0 for pre-merger period,

= 1 for post-merger period,

z_j is an error term for observation j.

SD_j is either $AISD_j$ or HSD_j.

Table 5.16 provides the results of the regression coefficients of the functions with the event-interaction effects. The results show no distinctive difference between the explanatory power of accounting risk models before and after merger in either samples. There is no shift in either the intercept or the slope of any function except for the HSD model of merger firms where the operating leverage is observed to be different in the postmerger period.

The Incremental Effects of Accounting Risk Measures

The question arises as to whether there is an incremental effect for accounting risk measures over a historical time series of return volatility in explaining the ex-ante measure of risk. A regression function for the dependent variable AISD is estimated as a function of HSD together with the selected accounting risk measures. The model can then be illustrated below.

TABLE 5.16
Summary Statistics for Accounting Risk Model
with Event-Interaction Effects:
Combined Event (n=102)

Dependent	Merger		Control	
	AISD	HSD	AISD	HSD
Independent	Regression Coefficient (t-value)			
Constant	.263 (4.95)***	.258 (5.11)***	.191 (3.08)***	.045 (0.53)
DE	.019 (5.02)***	.015 (4.22)***	-.004 (-.26)	.040 (1.99)**
CR	.006 (0.56)	.003 (0.35)	.032 (2.60)a	.052 (3.13)a
PO	.051 (1.96)b	.037 (1.50)	.012 (0.76)	.018 (0.87)
CV	.002 (3.39)***	.001 (2.44)***	.001 (3.98)***	.001 (2.56)***
OL	-.002(-1.15)	-.003(-1.53)	.040 (1.91)*	.055 (1.89)*
TA	-.000(-3.71)***	-.000(-2.45)***	-.000(-1.50)	-.000 (-.53)
MR	-.026(-1.08)	-.017 (-.76)	-.017(-0.80)	.014 (0.49)
PR	-.035 (-.49)	-.041 (-.61)	.052 (0.63)	.185 (1.61)
PR*DE	-.005(-1.05)	-.001(-0.27)	-.006 (-.29)	-.038(-1.37)
PR*CR	.008 (0.49)	.003 (0.17)	-.024(-1.37)	-.046(-1.91)*
PR*PO	-.030(-1.00)	-.021 (-.75)	-.053(-1.16)	-.085(-1.35)
PR*CV	-.000 (-.61)	.000 (0.32)	-.000 (-.06)	-.001 (-.21)
PR*OL	.001 (0.22)	.011 (2.64)***	-.016 (-.52)	-.009 (-.21)
PR*TA	.000 (1.54)	.000 (0.48)	.000 (0.95)	.000 (0.33)
PR*MR	.018 (0.55)	.002 (0.05)	-.006 (-.19)	-.041(-1.03)
F-model	6.361***	5.227***	4.674***	2.481***
Adjusted R^2	.443	.386	.353	.180

Note: * - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.
a - Significant at the 0.01 level of significance, but contrary to the expected directional hypothesis.
b - Significant at the 0.05 level of significance, but contrary to the expected directional hypothesis.

$$AISD_j = \beta_0 + \beta_1 HSD_j + \beta_2 DE_j + \beta_3 CR_j + \beta_4 PO_j + \beta_5 CV_j + \beta_6 OL_j + \beta_7 TA_j + \beta_8 MR_j + \phi_j \quad (5.3)$$

where $\beta_0, \ldots, \beta_8$ are regression coefficients, and

ϕ_j is an error term.

The regression coefficients of AISD as a function of HSD alone were also provided. The results were in table 5.11, as previously shown. The results of the above regression functions for merger and control samples for both periods are presented in table 5.17. The constant terms are all significant and positive for both samples during both periods. HSD is highly significant throughout. The values of adjusted R^2 are significantly higher with HSD included in the model than had been obtained earlier. That is, the R^2 values in table 5.17 are 0.733 and 0.637 for premerger period, and it should be compared against 0.455 (table 5.13) and 0.292 (table 5.14) of the AISD functions based on accounting risk measures alone. Similarly, the R^2 values of 0.614 and 0.539 in table 5.17 should be compared against 0.388 (table 5.13) and 0.401 (table 5.14). Furthermore, the R^2 for the AISD functions based on merely HSD, shown in table 5.11, were also high (ranging from 0.438 to 0.720). It is evident that, while HSD is highly significant explanatory variable of AISD, accounting measures add incremental explanatory power to HSD. It appears, however, that once the HSD is included in the model, the accounting risk measures seem to have smaller incremental effects on AISD. The debt-equity ratio and the coefficient of variation of EBIT continue to have significant effects for both samples in a premerger period, but for only one sample in a postmerger period.

TABLE 5.17

Results of the Test of Incremental Effects of ARMs
Model: AISD = f(HSD, ARMs)
(n=51)

Variable	Premerger Merger	Premerger Control	Postmerger Merger	Postmerger Control
	Regression Coefficient (t-value)			
Constant	0.050 (0.98)	0.168 (3.28)***	0.100 (2.35)**	0.160 (3.48)***
HSD	0.828 (6.77)***	0.516 (6.46)***	0.593 (5.12)***	0.359 (3.73)***
DE	0.006 (1.89)**	-0.025 (-1.97)**	0.006 (1.98)**	-0.010 (-1.04)
CR	0.003 (0.37)	0.005 (0.42)	0.010 (1.09)	0.005 (0.59)
PO	0.020 (1.01)	0.002 (0.17)	0.012 (1.21)	-0.017 (-0.55)
CV(EBIT)	0.001 (1.81)**	0.001 (2.49)**	0.001 (1.43)*	0.001 (3.33)***
OL	0.0001 (0.07)	0.012 (0.67)	-0.006 (-2.01)[a]	0.007 (0.44)
TA	-0.00001 (-2.21)**	-0.00001 (-1.37)*	-0.00001 (-1.10)	-0.00001 (-0.13)
MR	-0.012 (-0.63)	-0.024 (-1.39)	0.001 (0.09)	-0.013 (-0.88)
F-model	18.185***	11.942***	10.958***	8.307***
Adjusted R^2	0.733	0.637	0.614	0.539

Note: * - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.
a - Significant at the 0.05 level of significance, but contrary to the expected directional hypothesis.

The Predictive Ability

The predictive ability of premerger functions can be examined and compared in terms of prediction errors. The model of ex-ante or ex-post risk measures as a function of accounting risk measures during the premerger period was used as an approximation of equity risk measures during the postmerger period. The results are reported in table 5.18. The predicted error is small in all cases. While the predicted AISD is overstated, the predicted HSD is understated for both samples. The mean absolute error and the mean squared error are consistently larger for the HSD model in both cases. This implies that the ex-ante model reveals superior performance over the ex-post model of market-based risk estimates.

A Note on the Diversification Effect

A group of merger firms was partitioned into two groups due to the degree of diversification. Having removed one outlier from each of the partitioned groups during premerger and postmerger periods, 19 mergers were classified into conglomerates and 31 mergers were categorized as nonconglomerate (horizontal or vertical) mergers. The difference in statistics between these two groups was reported in table 5.19. There were no differences between the risk variables of the two groups during the premerger period. Nevertheless, in the postmerger period, the ex-ante and ex-post risk measures estimated from market data showed a significant difference as observed by AISD and HSD measures. The evidence implied that the market anticipated the equity risk to be different after merger between conglomerate and nonconglomerate mergers.

TABLE 5.18

Analyses of Prediction Errors

	Predicting Variable			
	Merger		Control	
	PAISD[1]	PHSD[2]	PAISD[3]	PHSD[4]
Mean error	.0381	-.0108	.0148	-.0059
Mean absolute error	.0582	.0584	.0537	.0665
Mean square error	.0053	.0057	.0041	.0078
Mean prediction	.3591	.2985	.3340	.3155
Mean actual variable	.3210	.3092	.3192	.3214
Adjusted R^2	.455	.381	.292	.165

Note:

1. $PAISD_j = .264 + .019DE_j + .006CR_j + .051PO_j + .002CV_j - .002OL_j - .00001TA_j - .026MR_j + u_j$

2. $PHSD_j = .254 + .015DE_j + .003CR_j + .037PO_j + .001CV_j - .003OL_j - .00001TA_j - .017MR_j + v_j$

3. $PAISD_j = .191 - .004DE_j + .032CR_j + .012PO_j + .001CV_j + .041OL_j - .000004TA_j - .017MR_j + w_j$

4. $PHSD_j = .045 + .041DE_j + .052CR_j + .018PO_j + .001CV_j + .055OL_j - .000002TA_j + .014MR_j + z_j$

The t-test for the differences of the risk variables between the periods before and after merger was shown in table 5.20. The ex-ante risk measure (AISD) for conglomerate mergers showed a significant decrease after merger, while no difference in risk variables was detected in nonconlomerate mergers.

A Note on the Accounting Method Effect

From a group of 50 merger firms after removing two outliers presented in either periods before and after merger, 43 mergers were identified as using the purchase accounting method and 7 firms using the pooling method. The univariate analysis of the risk variables for the periods premerger and postmerger is presented in table 5.21. The mean statistics for AISD and HSD were significantly higher for those mergers using the pooling method than those using the purchase accounting method during the premerger period. Only HSD was significantly different between the two groups after merger. No difference in accounting risk measures between both groups could be observed during both periods. Except for the AISD estimate of the pooling group that significantly decreased after merger, no significant differences in other risk variables could be distinguished for both groups in the periods before and after merger, as shown in table 5.22. It should also be noted that the sample firms were obtained from the CBOE firms which were subject to limitations due to large size and small numbers. Only 7 firms were identified as those using a pooling method. Consequently, the accounting impact cannot be efficiently inferred. In order to detect an accounting impact, an extensive sample other than those including in the CBOE firms should be used.

A test of the explanatory power of accounting risk measures was performed for a merger sample engaging only in the purchase method of accounting. The results, as shown in table 5.23, were consistent with the analysis using the total merger sample, as compared to table 5.13. That is, the debt-equity ratio as well as CV(EBIT) were the most significant variables in approximating both AISD and HSD for both periods before and after merger.

Summary

This chapter presents three types of evidence relating to the following hypotheses: (1) the impact of merger on the equity risk of the combined firm; (2) the consistency and substitutability of ex-ante and ex-post risk estimates; and (3) the predictive ability of accounting risk measures. The univariate analyses were used to test the differences of risk changes between merger and control samples. The consistency of ex-ante and ex-post risk estimates was tested using correlation as well as regression analyses. The multivariate analyses were employed to evaluate the explanatory power of accounting risk measures. The results of the tests were then discussed for each of the study objectives.

TABLE 5.19

Univariate Statistics for Partitioned Merger Firms According to Merger Types

Variable	Conglomerates (n=19) Mean	Conglomerates (n=19) Standard Deviation	Nonconglomerates (n=31) Mean	Nonconglomerates (n=31) Standard Deviation	t-value
			Premerger		
AISD	0.3324	0.0742	0.3610	0.1066	-1.118
HSD	0.3040	0.0621	0.3349	0.0859	-1.469
DE	0.9990	0.4435	2.1000	4.1283	-1.471
CR	1.8533	0.6613	2.1655	1.2393	-1.159
PAYOUT	0.5544	0.5805	0.3233	0.3392	1.579
CV(EBIT)	41.6905	19.9233	49.7540	19.8978	-1.390
OL	1.3138	0.3487	-0.0910	7.0932	1.101
TA	4182.8122	3129.9141	4054.5558	3327.6572	0.137
MR	0.4169	0.4660	0.4172	0.4659	-0.002
			Postmerger		
AISD	0.2787	0.0582	0.3475	0.0770	-3.577***
HSD	0.2839	0.0753	0.3251	0.0820	-1.816*
DE	1.1201	0.4276	2.3986	4.6962	-1.506
CR	1.8484	0.7435	1.9956	0.9586	-0.607
PAYOUT	0.2248	1.1759	0.3622	0.3539	-0.496
CV(EBIT)	41.1358	19.8802	48.2981	19.5201	-1.245
OL	2.6964	4.4169	1.1765	0.2932	1.498
TA	4606.6636	3441.5670	5003.1981	4540.8658	-0.349
MR	0.2528	0.4555	0.3430	0.4878	-0.662

Note: * - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.

TABLE 5.20

Test of Differences in Level of Risk Variables Between Two Periods
Conglomerate vs. Nonconglomerate Mergers

Variable	Conglomerates (n=19)	Nonconglomerates (n=31)
	t-value (post-pre)[a]	
AISD	-2.482**	-0.573
HSD	-0.899	-0.458
DE	0.857	0.266
CR	-0.021	-0.604
PAYOUT	-1.096	0.442
CV(EBIT)	-0.086	-0.291
OL	1.360	0.994
TA	0.397	0.938
MR	-1.097	-0.612

Note: a - Negative t-value means the postmerger risk measure is less than that premerger.
** - significant at the 0.05 level of significance.

TABLE 5.21

Univariate Statistics for Partitioned Merger Firms According to Accounting Methods Used

Variable	Purchase (n=43) Mean	Purchase (n=43) Standard Deviation	Pooling (n=7) Mean	Pooling (n=7) Standard Deviation	t-value
			Premerger		
AISD	0.3343	0.0897	0.4478	0.0755	3.163***
HSD	0.3106	0.0749	0.4001	0.0547	3.021***
DE	1.4129	2.7372	3.3323	5.6608	0.881
CR	1.9842	0.7342	2.4320	2.2820	0.515
PAYOUT	0.4268	0.4612	0.3147	0.4355	-0.600
CV(EBIT)	46.7389	20.2598	46.3887	20.6096	-0.042
OL	0.3385	6.0361	1.0837	0.4605	0.796
TA	4169.3173	3160.7963	3697.7170	3824.9596	-0.356
MR	0.4210	0.4634	0.3928	0.4822	-0.149
			Postmerger		
AISD	0.3183	0.0764	0.3402	0.0882	0.688
HSD	0.2981	0.0748	0.3793	0.0901	2.590**
DE	1.6061	3.0589	3.7966	6.6118	0.862
CR	1.9582	0.8163	1.8257	1.2701	-0.267
PAYOUT	0.3339	0.8037	0.1631	0.5099	-0.542
CV(EBIT)	45.5355	19.7095	45.8278	21.7309	0.036
OL	1.4229	0.9209	3.7884	7.2071	0.867
TA	4964.7361	4100.3800	4163.1570	4539.0186	-0.473
MR	0.3351	0.4783	0.1466	0.4369	-0.977

Note: * - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.

TABLE 5.22

Test of Differences in Level of Risk Variables Between Two Periods
Purchase vs. Pooling Accounting Methods

Variable	Purchase (n=19)	Pooling (n=31)
	t-value (post-pre)[a]	
AISD	-0.889	-2.453**
HSD	-0.776	-0.524
DE	0.309	0.141
CR	-0.155	-0.614
PAYOUT	-0.658	-0.598
CV(EBIT)	-0.279	-0.050
OL	1.165	0.991
TA	1.008	0.208
MR	-0.845	-1.001

Note: a - Negative t-value means the postmerger risk measure is less than that of premerger.
** - significant at the 0.05 level of significance.

TABLE 5.23

Summary Statistics for Accounting Risk Model:
Merger Sample (Purchase Accounting Only)
(n=43)

Dependent	Expected Sign	Premerger AISD	Premerger HSD	Postmerger AISD	Postmerger HSD
Independent		Regression Coefficient (t-value)			
Constant	(+)	0.234 (3.36)***	0.279 (4.80)***	0.198 (3.12)***	0.192 (2.98)***
DE	(+)	0.017 (3.49)***	0.014 (3.32)***	0.015 (3.95)***	0.012 (3.05)***
CR	(-)	0.011 (0.61)	-0.007 (-.46)	0.013 (0.85)	0.005 (0.31)
PO	(-)	0.051 (1.79)[a]	0.037 (1.55)	0.024 (1.76)[a]	0.024 (1.73)[a]
CV(EBIT)	(+)	0.002 (3.01)***	0.001 (2.56)***	0.002 (3.22)***	0.001 (2.88)***
OL	(+)	-0.003 (-1.40)	-0.002 (-1.45)	0.013 (1.04)	0.027 (2.06)**
TA	(-)	-0.00001 (-2.64)***	-0.00001 (-2.73)***	-0.00001 (-1.93)**	-0.00001 (-1.79)**
MR	(+)	-0.022 (-0.79)	-0.031 (-1.33)	0.004 (0.18)	-0.016 (-0.69)
F-model		5.432***	5.399***	4.261***	3.622***
Adjusted R^2		0.419	0.417	0.347	0.299

Note: * - Significant at the 0.10 level of significance.
** - Significant at the 0.05 level of significance.
*** - Significant at the 0.01 level of significance.
a - Significant at the 0.10 level of significance for a two-tailed test, but contrary to the expected directional hypothesis.

CHAPTER VI
SUMMARY AND CONCLUSIONS

Summary and Discussion

The preceding chapter presents the results of empirical tests of the three hypotheses relating to the merger impact, the evaluation of ex-ante and ex-post estimates of equity risk, and the predictive ability of the accounting risk measures. The overall results and discussion can be summarized as follows:

1. The univariate t-tests for differences in levels of equity risk between periods showed a significant decrease in the ex-ante, but not in the ex-post, estimate of equity risk. Consistent results were also obtained using nonparametric tests. However, no distinction can be made as to the differences in magnitudes of change in equity risk between merger and control samples. Therefore, consistent with Mandelker [1974]'s conclusions, risk changes may not be due to merger, but to extraneous factors that affect the stability of risk variables. Furthermore, the change in debt-equity ratio in the merger sample is quite different from that of the control sample. This result is consistent with the coinsurance hypothesis regarding the shareholders' wealth protection via increasing leverage after merger.

2. The ex-post estimate of equity risk is highly correlated with the ex-ante estimate for both samples in both periods, although the correlation is different from unity. The coefficient estimate of regressing AISD on HSD approaches one for only the merger sample in the

premerger period. The functional relationship between AISD and HSD is significantly different between merger and control firms during the premerger period, but not in the postmerger period. The evidence implies that HSD can be a good estimate of equity risk in absence of the merger event. Nevertheless, when mergers occur, the risk estimate using AISD provides more intuitive results than that using HSD.

The results of regressing equity risk on accounting variables yielded consistently high explanatory power as reflected by adjusted R^2 values ranging between 0.292 and 0.455 for the AISD functions, and between 0.165 and 0.389 for the HSD functions. The difference in explanatory power between AISD and HSD suggests that accounting risk measures appear to be impounded in the ex-ante risk measure (AISD) more than in the ex-post risk estimate (HSD). Consistent results were obtained from analyses of prediction errors, where the premerger AISD models had smaller mean absolute errors and mean squared errors than those of the HSD models.

3. As to the predictive ability of those accounting risk measures, two accounting risk factors that are found to be highly significant in explaining the variation of AISD and HSD are the debt-equity ratio and the coefficient of variation in EBIT. No distinction can be made, however, in the significance of accounting risk factors between the two periods of premerger and postmerger. Finally, the incremental effects of accounting risk variables were substantially lower when HSD is added as an explanatory variable.

Given the mean-variance context where a higher return is expected from a firm with higher risk, the lack of increase in risk suggests that investors of acquiring firms may not expect to gain from merger.

4. The merger sample was also partitioned into conglomerates and nonconglomerates. The supplementary test of the differences between the risk variables within these groups did not show distinction between the equity risk of merger and control samples in the premerger period. A significantly greater decrease in the ex-ante risk measure (AISD) is obtained for conglomerate mergers than for nonconglomerate mergers in the postmerger period.

5. Subject to the limitation of having selected a small sample from the CBOE, the impact of accounting methods used in mergers could not be properly analyzed. Only 7 firms in the sample were identified as using the pooling method, while 43 firms analyzed used the purchase method of accounting. The univariate analysis showed a significant difference between these two groups for both AISD and HSD in the premerger period, but a significant difference in only HSD after merger. This analysis, however, suffers from using a very small sample for the group using the pooling method.

Conclusions

This study examined (1) the impact of merger on the equity risk of the combined firm; (2) the substitutability of ex-ante and ex-post measures of equity risk; and (3) the extent to which accounting risk measures are instruments for market equity risk before and after merger. Three types of evidence were investigated to evaluate changes in risk as a consequence of merger. First, the implied standard deviation derived from the (Merton's generalization of) Black-Scholes option pricing model was used for the ex-ante measure of stock volatility before and after

merger. Second, the historical time-series standard deviation of daily returns for six months was employed as the ex-post estimate of market-based risk. Finally, accounting risk measures were evaluated in terms of their ability to explain and predict changes in risk as affected by merger.

A set of 51 merger and 51 control (nonmerger) firms was examined in testing the above hypotheses. The assessments of market-based risk show evidence of risk reduction after merger for the sample firms. Yet, no distinction can be made as to the difference of risk changes between merger and control firms. The observed changes in AISD and HSD for both samples may imply the instability of return volatility over time. A high association between ex-ante (AISD) and ex-post (HSD) risk measures in both periods before and after merger points to their consistency. From the premerger similarity of AISD and HSD, it can be inferred that the historical time-series estimate of stock volatility is a viable alternative in approximating future stock volatility.

The evidence also supports the hypothesis that accounting risk measures are impounded in the market-based estimation of risk for both the ex-ante and the ex-post analyses. The results are consistent for both samples. Accounting generated variables, therefore, reflect the basic underlying characteristics that are contained in market-based risk measures. Though significant, the incremental explanatory power of accounting variables over HSD is low. The merger sample has a significant increase in debt-equity ratio, which is consistent with the expectation that investors react to protect their wealth transfer to bondholders. An increase in financial leverage after merger leads to

an increase in equity risk, and, in turn, partially offsets the reduction of risk from an increase in size and diversification.

Limitations

Certain limitations regarding the quality of data and sample were encountered. First, data for AISD variables as an input to the option pricing model would be estimated more efficiently if a simultaneous transaction data of stock and option prices were used. This is not usually feasible due to the infrequency of trade. Eight companies in the merger group and three in the control sample had infrequent trading. For this reason, averages of bid-ask spreads were used instead, giving rise to an estimation that reduced the accuracy of the ISD calculation.

Second, the problem of self-selection bias is present. The firms under investigation are drawn from the Chicago Board of Options Exchanges market. These companies are large firms. Therefore, a significant difference between the merger and control firms may not be easily detectable.

Implications for Future Research

The findings in this study are consistent with existing research on ISD in that ISD shows superior performance over HSD (Black and Scholes [1972], Latane and Rendleman [1976], and Patell and Wolfson [1979, 1981]). Information content studies began to benefit by incorporating other ex-ante volatility measures. Ajinkya and Gift [1985] have suggested the dispersion of financial analysts' forecasts as an alternative measure of earnings variability. The relative advantage of

AISD as compared to other measures stems from the fact that AISD is generated from equilibrium prices in the market place.

Although the Black-Scholes model does not hold exactly for in-the-money or out-of-the-money options, an estimate of ISD using the average across various exercise prices is likely to randomize systematic biases. This approach can be used in comparison with the ISD estimated from at-the-money options.

A further problem arises from omitted variables in accounting risk measures, since the models' highest R^2 is 0.455. Certain factors affecting equity risk might include management efficiency, monopoly power, and expected interest rates. These variables, though not easily observable, were suggested by prior research (e.g., Rubinstein [1973], Lev [1974], and Subrahmanyam and Thomadakis [1980]). An examination of what variables are impounded in the investors' expectation of equity risk should provide useful information for investment decision making.

Finally, some areas for further work might include (1) refinements in the measurement of financial leverage and operating leverage, and (2) improved methods for risk decomposition.

APPENDIX A

LIST OF MERGER AND TARGET FIRMS

Merger	Target	Merger Date
1. Baxter Travenol Labs (BAX)	Medcom Inc.	5/14/82
2. Control Data (CDA)	Tabershaw Assoc.	9/13/82
3. Delta Airlines (DAL)	Travelink Ltd.	10/1/82
4. General Foods (GF)	Entenmann's Inc.	11/23/82
5. Great Western Fin. (GWF)	Northern Calif S&L	7/31/82
6. Honeywell (HON)	Disc Instruments	12/30/82
7. Johnson & Johnson (JNJ)	\`A' Co.	5/3/82
8. National Semiconductor (NSM)	Xciton Corp.	6/2/82
9. Occidental Petroleum (OXY)	Cities Services Co.	12/3/82
10. Owens-Illinois (OI)	Kontes Glass Co.	11/11/82
11. RCA Corp.	CYLIX Communication	10/1/82
12. Reynolds Industries (RJR)	Heublein Inc.	10/12/82
13. Squibb (SQB)	Advanced Diagnostic	6/28/82
14. Tandy (TAN)	Memorex Corp.	4/1/82
15. Viacom International (VIA)	Showtime	11/4/82
16. Weyerhaeuser (WY)	Wight Industries	11/12/82
17. United Technologies (UTX)	General Dynamics-Communications	7/26/82
18. Aluminum Co. of America (AA)	CNG Cylinder Corp.	9/9/83
19. Avon Products (AVP)	Contamination Control	8/4/83
20. Bally Manufacturing (BLY)	Health & Tennis Corp.	6/6/83
21. Burlington Northern (BNI)	El Paso	2/8/83
22. CBS Inc. (CBS)	Camera Arts	5/17/83
23. Capital Cities Comm. (CCB)	Securities Data Co.	8/16/83
24. General Dynamics (GD)	El Paso Sand	3/31/83
25. Johnson & Johnson (JNJ)	Irex Corp.	2/24/83
26. Litton Industries (LIT)	Itek Corp.	3/4/83
27. Medtronic (MDT)	Andover Medical Inc.	4/30/83
28. Monsanto (MTC)	Fisher Controls	7/11/83
29. Natioanl Semiconductor	Data Terminal System	5/31/83
30. Polaroid (PRD)	1984 Inc.	4/27/83
31. Raytheon (RTN)	Colorado Jet Center	6/27/83
32. Reynolds Industries (RJR)	Dixico Inc.	4/15/83
33. Upjohn (UPJ)	United Home Health	2/1/83
34. Viacom International (VIA)	KSLA-TV Inc.	6/3/83
35. Xerox (XRX)	Crum and Foster	1/11/83
36. Williams Companies (WMB)	North West Energy	12/1/83
37. Upjohn (UPJ)	O's Gold Seed Co.	12/29/83
38. Tandy (TAN)	O' Sullivan Inds.	12/30/83

APPENDIX A - CONTINUED

Merger	Target	Merger Date
39. Harris (HRS)	Lanier Business	10/28/83
40. Honeywell (HON)	Kraden Comm.	10/25/83
41. K-Mart (KM)	Bishop Buffet	12/21/83
42. Great Western Financial (GWF)	Aristar Inc.	10/7/83
43. General Foods (GF)	Ronzoni Macaroni	2/21/84
44. Capital Cities Comm. (CCB)	Sutton Inds.	3/5/84
45. American Hospital Supply (AHS)	Medifac Co.	2/8/84
46. Colgate-Palmolive (CL)	Anatros Corp.	3/26/84
47. Burroughs (BGH)	Graphics Technics	2/23/84
48. Reynolds (RJR)	Canada Dry Corp.	4/9/84
49. Homestake Mining (HM)	Felmont Oil Corp.	6/19/84
50. Avon Products (AVP)	Foster Medical	5/30/84
51. Disney (Walt) Prods. (DIS)	Arvida Corp.	6/6/84
52. Schlumberger Ltd. (SLB)	Sedco Inc.	12/24/84

APPENDIX B
DERIVATIONS OF EXPECTED CHANGES IN THE RISK COMPONENTS

Financial Risk Effect

Given MM's Proposition I (the "irrelevance" theorem), the total market value of a firm and the distribution of its earnings are independent of the firm's capital structure. It follows that

$$\sigma(S_j) = \frac{\sigma(P_j)}{V_j}\left[1 + \frac{D_j}{S_j}\right]$$

$$\frac{\partial\sigma(S_j)}{\partial\left(\frac{D_j}{S_j}\right)} = \frac{\sigma(P_j)}{V_j} .$$

Operating Risk Effect

The coefficient of variation in operating earnings or earnings before interest and taxes is used as a proxy for operating risk. Given equation 3.6 in chapter III, the equity risk is a function of the following components:

$$\sigma(S_j) = \frac{\frac{\sigma(P_j)}{E(P_j)} \cdot R_f}{1 - \lambda\frac{\sigma(P_j)}{E(P_j)}\sigma(P_m)\ \rho(P_jP_m)} \cdot \left(1 + \frac{D_j}{S_j}\right)$$

The derivative of the equity risk function with respect to the coefficient of variation in operating earnings can be derived below.

Let $CV(P_j) = \frac{\sigma(P_j)}{E(P_j)}$, and by the quotient rule,

$$\frac{\partial\sigma(S_j)}{\partial CV(P_j)} = \left[1+\frac{D_j}{S_j}\right] \frac{\{[1-\lambda CV(P_j)\sigma(P_m)\rho(P_jP_m)]\ R_f - CV(P_j)R_f\ (-\lambda\sigma(P_m)\rho(P_jP_m)}{[1-\lambda CV(P_j)\sigma(P_m)\rho(P_jP_m)]^2}$$

$$= \left[1+\frac{D_j}{S_j}\right] \frac{[R_f - R_f\,\lambda CV(P_j)\sigma(P_m)\rho(P_jP_m) + R_f\lambda CV(P_j)\sigma(P_m)\rho(P_jP_m)]}{[1 - \lambda CV(P_j)\sigma(P_m)\rho(P_jP_m)]^2}$$

$$= \left[1+\frac{D_j}{S_j}\right] \frac{R_f}{[1 - \lambda CV(P_j)\sigma(P_m)\rho(P_jP_m)]^2}$$

<u>Correlation of Earnings Effect</u>

The change in equity risk with respect to the correlation between a firm's earnings and market earnings $[\rho(P_jP_m)]$ is derived as follows:

$$\frac{\partial\sigma(S_j)}{\partial\rho(P_jP_m)} = \left[1+\frac{D_j}{S_j}\right] \frac{(-1)\,\frac{\sigma(P_j)}{E(P_j)} \cdot R_f \left[-\lambda\frac{\sigma(P_j)}{E(P_j)} \cdot \sigma(P_m)\right]}{\left[1 - \lambda\frac{\sigma(P_j)}{E(P_j)}\,\sigma(P_m)\,\rho(P_jP_m)\right]^2}$$

$$= \left[1+\frac{D_j}{S_j}\right] \frac{\lambda\,\left[\frac{\sigma(P_j)}{E(P_j)}\right]^2 \cdot R_f \cdot \sigma(P_m)}{\left[1 - \lambda\frac{\sigma(P_j)}{E(P_j)}\,\sigma(P)\,\rho(P_jP_m)\right]^2}$$

Since $V_j = \dfrac{1 - \lambda CV(P_j)\,\sigma(P_m)\,\rho(P_jP_m)}{\frac{R_f}{E(P_j)}}$,

therefore, the above function becomes

$$= \left[1 + \frac{D_j}{S_j}\right] \left[\frac{\sigma(P_j)}{V_j}\right]^2 \frac{\sigma(P_m)}{R_f}\lambda.$$

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BIOGRAPHICAL SKETCH

Pornsiri Pringsulaka Poonakasem was born on May 15, 1952, in Nakorn Srithammarat, Thailand. She received her Bachelor of Accounting degree with honors in 1973 from Chulalongkorn University, Thailand. Upon graduation, she worked as a financial analyst with Bangkok Bank Ltd., Thailand for two years. Subsequently, she obtained a fellowship which enabled her to study for the Master of Accounting Science degree at the University of Illinois at Urbana-Champaign in 1976. She then returned to Thailand and worked in Bangkok with the Audit Council of Thailand for four years. She was also appointed as a faculty member with the Department of Commerce and Accountancy, Chulalongkorn University, Thailand.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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E Dan Smith

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Professor of Accounting

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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Associate Professor of Finance,
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This dissertation was submitted to the Graduate Faculty of the Fisher School of Accounting in the College of Business Administration and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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